ENGINEERING AND MINING JOURNAL

1957 MINING GUIDEBOOK

AND BUYING DIRECTORY ISSUE

MID-JUNE 1957

A McGRAW-HILL PUBLICATION

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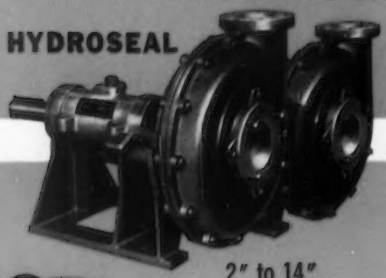
HYDROSEAL **CENTRISEAL**

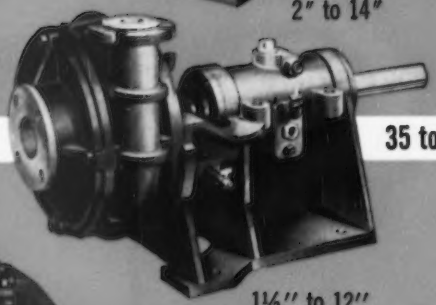
SLURRY — 400 to 8 mesh — ***Delivers pulp undiluted***



2″ to 14″

HYDROSEAL

SAND — 35 to 4 mesh



1½″ to 12″

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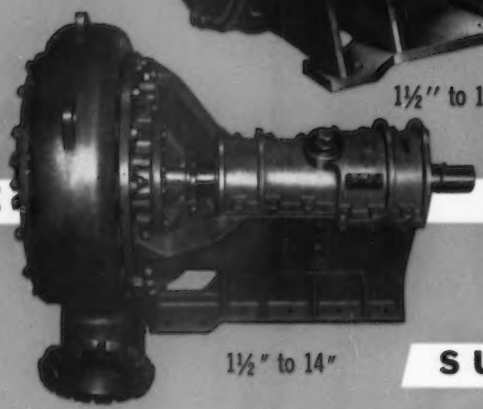

1½″ to 14″

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Whatever the conditions, you can select an A-S-H pump that will do the job better and longer at less operating cost. Proper application and maximum benefit will be assured, for our initial-and-continued engineering is importantly aided by kept-up performance records of our pumps in mining and processing operations throughout the Free World. Take this first step today .....

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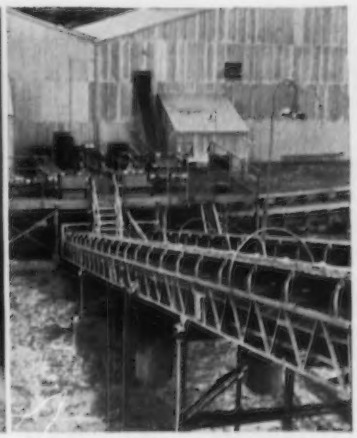

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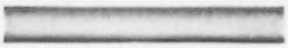

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Covered with tough plastic material, not affected by high Summer heat or Winter cold. Waterproof—resistant to acids commonly encountered. Use for extremely deep holes, river crossings, field shots that must stand for long periods of time and in other wet conditions. Tensile strength 275 lbs. 1000-ft. spool 22 lbs.

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Textile-covered, flexible and resilient. Suitable for surface trunk lines and shallow holes where tensile strength and resistance to abrasion and cutting are not required. Tensile strength 125 lbs. 1000-ft. spool 17 lbs.

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Armored with wire and covered with plastic material. Recommended for use in deep, ragged holes or with metal or fibre explosives containers, where strength and resistance to abrasion and cutting are essential. Tensile strength 300 lbs. 1000-ft. spool 33 lbs.

Here are five types of Ensign-Bickford Detonating Fuse, each developed and field-tested to meet certain conditions in use. For your trunk lines in primary blasting, Plain Primacord or Reinforced Primacord serves in most cases. Detacord provides an economical detonating agent for use in secondary, long hole underground and pipe line ditch blasting, but should not be used in primary blasts.

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Used for connecting and igniting safety fuse in rounds. Burns progressively with a short hot external flame at the zone of burning. Type A, 8 to 10; Type B, 16 to 20 seconds per foot. 100-ft. spools. Ignitacord Connectors — 100 in a box.

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Pyrotechnical Devices and Blasting Accessories

ENGINEERING AND MINING JOURNAL MINING GUIDEBOOK

MID-JUNE 1957 Volume 158, No. 6a

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Your 1957 Guidebook

WHAT IT IS. This is the fourth annual *E&MJ* Mining Guidebook and Buying Directory issue. It is designed to work with its predecessors in giving you the information you have told us you need to do a better job in planning exploration, mining, milling and smelting projects.

The editors of *E&MJ* mailed more than 3,000 questionnaires to mining companies and manufacturers requesting information for this Guidebook. Their generous cooperation makes this issue and extremely valuable collection of "firsts" in methods, equipment and facts —brought together in tables, charts and panorama presentations that you will find useful for many years to come.

HOW TO USE IT. If you're planning a new project or revamping an old one, you can do the job better with the help of the Guidebook and Buying Directory issue. You'll find capacities, dimensions and performance data here. And, by using the Guidebook section in conjunction with the Buying Directory and the advertisements appearing in the issue you can find out all you need to know before purchasing.

Published monthly with an additional issue in Mid-June by McGraw-Hill Publishing Co., Inc., James H. McGraw (1860-1948), founder. Publication Office: 1309 Noble St., Philadelphia 23, Pa. See panel below for directions regarding subscription or change of address.

Executive, Editorial, Advertising and Subscription Offices: McGraw-Hill Building, 330 West 42nd St., New York 36, N. Y. Donald C. McGraw, president; Joseph A. Gerardi, executive vice president and treasurer; John J. Cooke, secretary; Nelson Bond, executive vice president, publications division; Ralph B. Smith, vice president and editorial director; Joseph H. Allen, vice president and director of advertising sales; A. R. Venezian, vice president and circulation coordinator.

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Subscription rates for individuals in the field of the publication: United States and possessions $4 a year; $6 for two years; single copy $1. Canada $5 a year; $8 for two years; single copy $1. Other Western Hemisphere and Philippines $8 a year; $12 for two years; $16 for three years; single copy $1.50. Elsewhere $15 a year; $25 for two years; $30 for three years; single copy $2.

Entered as second class matter May 24, 1951 at the Post Office at Philadelphia, Pa., under the Act of March 3, 1879. Title registered in the U. S. Patent Office.

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ABP

SUBSCRIPTIONS: Send subscription correspondence and change of address to Subscription Manager, ENGINEERING & MINING JOURNAL, 330 West 42nd Street, New York 36, N. Y. Subscribers should notify Subscription Manager promptly of any change of address, giving old as well as new address, and including postal zone number, if any. If possible, enclose and address label from a recent issue of the magazine. Please allow one month for change to become effective.

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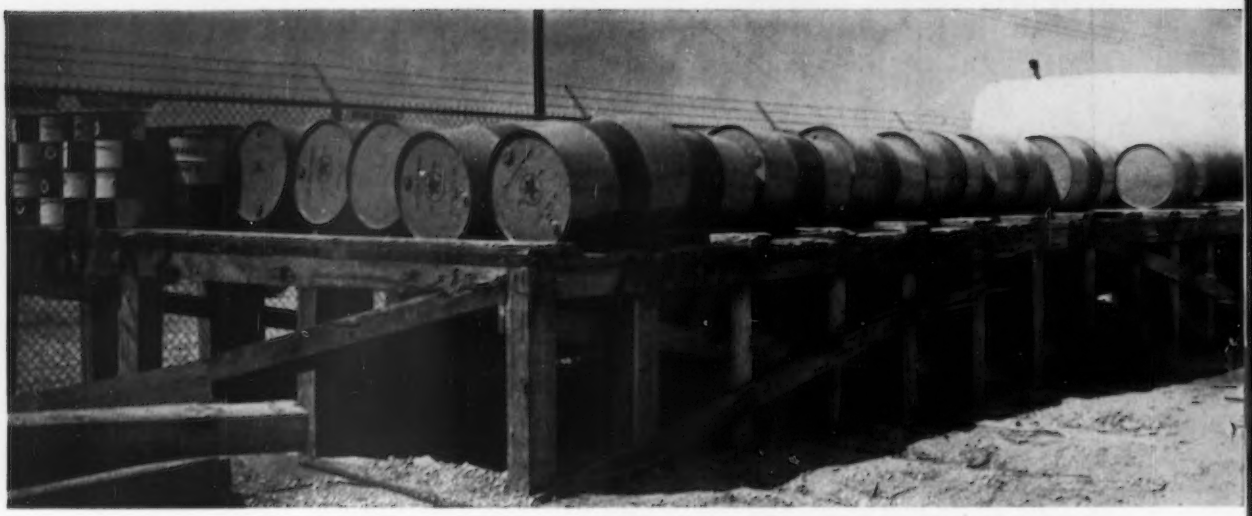
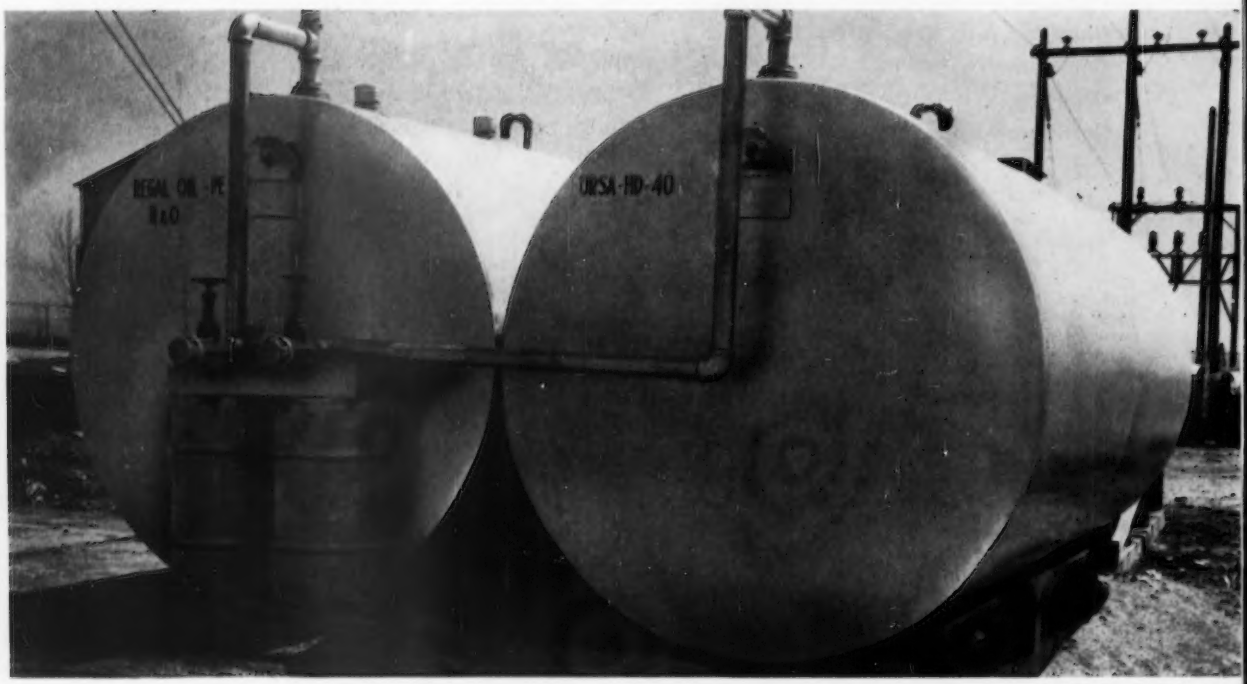


ONCE, International Minerals & Chemical Corporation, Carlsbad, New Mexico, bought its Texaco Lubricants in 55-gallon drums. These were stored on platforms at the shafts. When needed, they had to be moved, largely by hand, to the cage; and from the cage to mine haulage equipment underground.



NOW, bulk storage is used. These tanks located at each shaft are easily filled, hold 4,000 gallons of oil each. Pipelines running down the shafts carry the oil from the tanks out to the underground haulage system. Safety valves control the flow of oil from the pipelines.

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every Saturday afternoon

TEXACO

UNIQUE OIL HANDLING SYSTEM SAVES TIME, CUT COSTS

AN IDEA FOR YOU?

This new oil handling system increases efficiency, promotes safety, reduces costs. International Minerals & Chemical Corporation engineers, working with Texaco Lubrication Engineering Service, designed the system for their Carlsbad, New Mexico, potash mine. Much of the equipment was fabricated by International's own maintenance crew. The entire installation has been approved by the State Mine Inspector, and is the first of its kind in New Mexico.

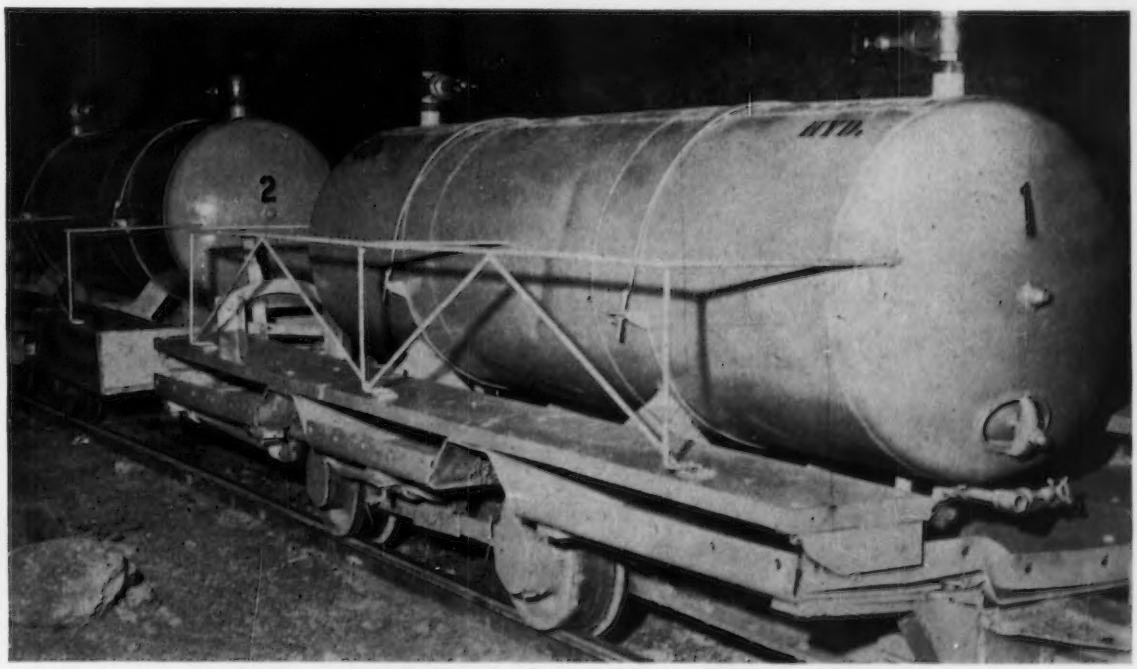
Perhaps you can adapt this simplified method of lubricant handling to your mining operation. Certainly you can benefit from the use of Texaco Lubricants in your mine. International Minerals & Chemical Corporation has used them for more than 20 years.

There is a complete line of Texaco Lubricants—oils and greases—especially designed for the needs of mining equipment, above and below ground. The benefits—trouble-free performance, increased production, lower maintenance costs—are so consistently delivered that Texaco has long been tops in the mining field. In fact—

For over 20 years, more copper ore in the U.S. has been mined with Texaco-lubricated equipment than with any other.

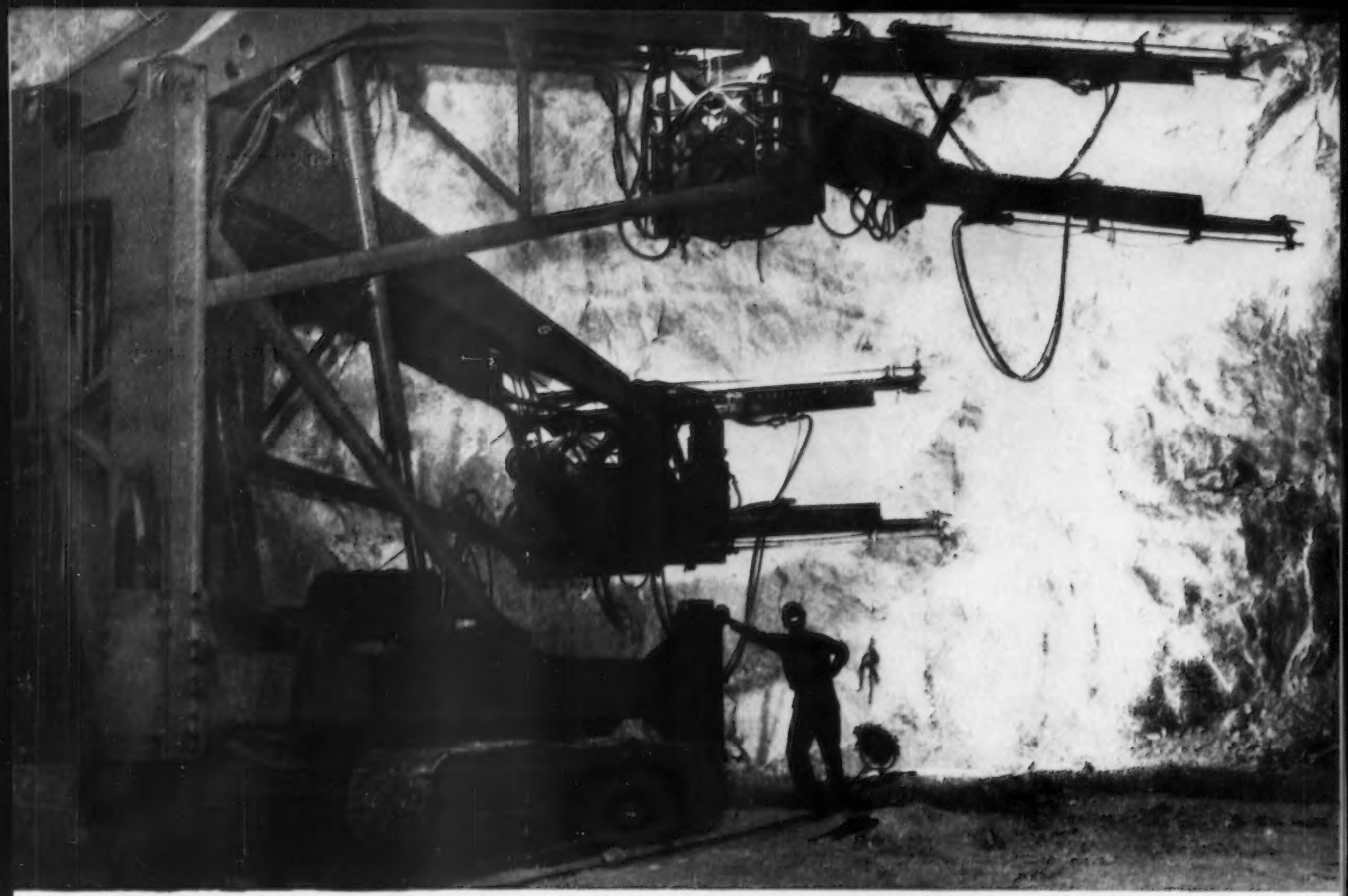
Let a Texaco Lubrication Engineer give you the full story. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, New York.



NOW, underground tank cars move the oil to working areas throughout the mine. Some cars run on rails; others are rubber-tired and hauled by shuttle cars. Tanks are compartmented to carry two different Texaco oils. This practical system has brought about substantial savings in time, effort and money.

Lubricants and Fuels
FOR THE MINING INDUSTRY



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HYDRA-BOOMS. Available with extendable and non-extendable features and with hydraulic power cone, dump and swing.

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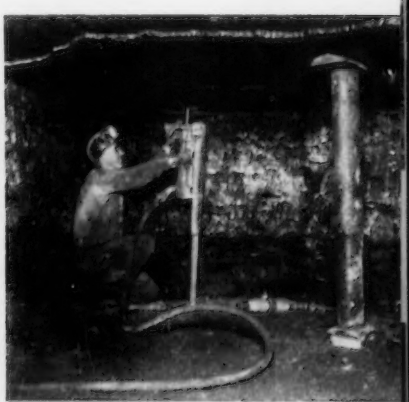

SHORT-LEG STOPER. Lightweight and easy to handle, the I-R Short-Leg Stoper is designed *specifically* for low-cost rock bolting.

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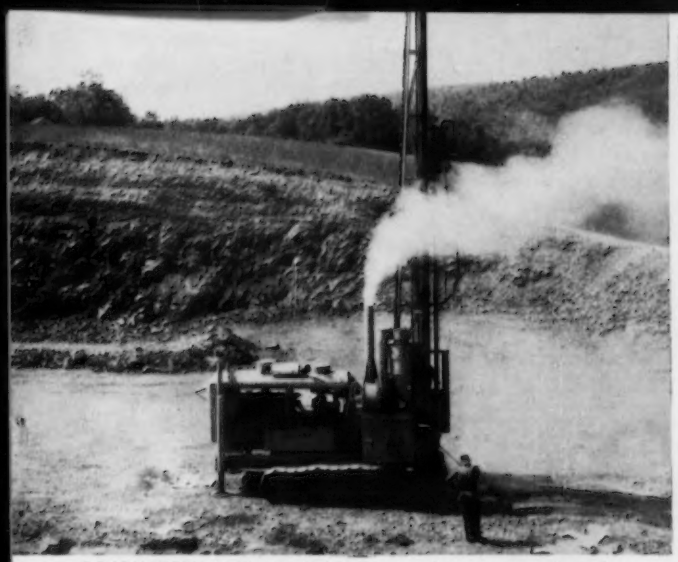

DRILLMASTER. If it's big holes you're after, on a real production basis, you can't buy a more productive drilling machine than the I-R Drillmaster.

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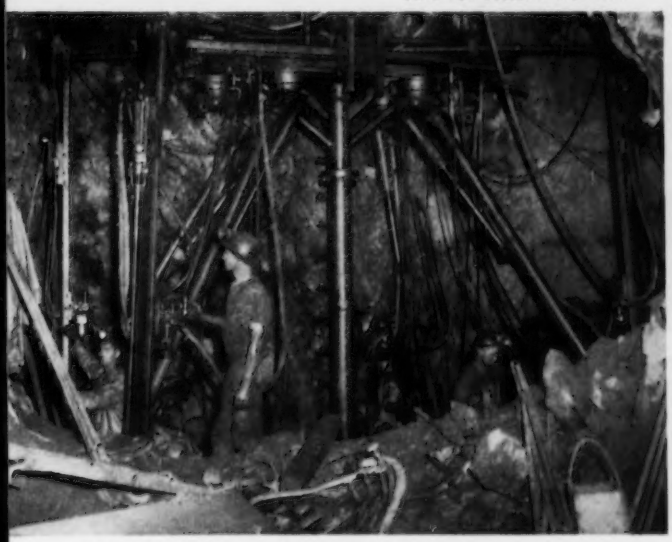

SHAFT JUMBOS. I-R Hydra-Boom Shaft Jumbos save set-up time, drilling time, manpower.

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CRAWL-IR. Here in one rugged package is self-propelled crawler drill with *all* boom and feed-tower adjustments controlled hydraulically.

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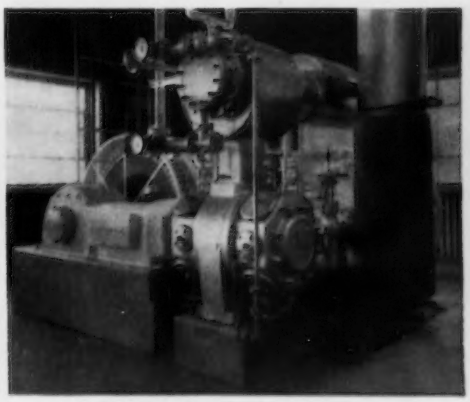

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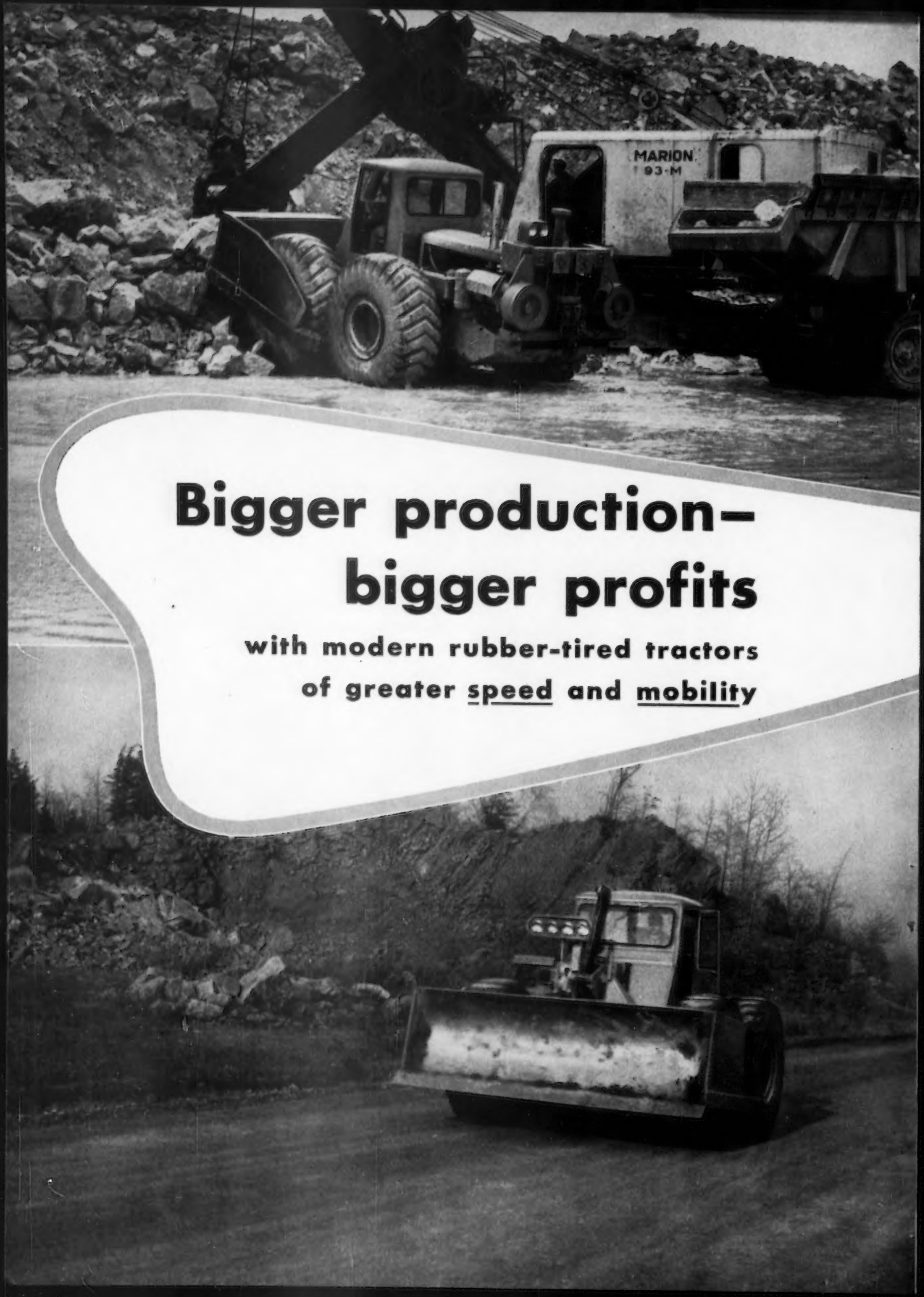
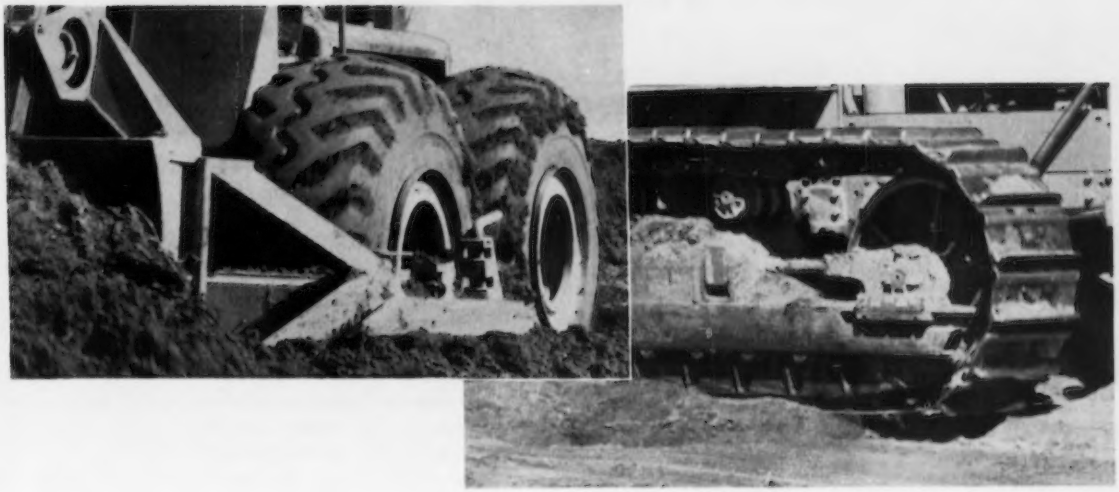


Bigger production— bigger profits

with modern rubber-tired tractors of greater speed and mobility



Today's needs demand tractors that have 4 major dimensions

Your tractor requirements for work around pit and plant have changed considerably during the past few years. Time was when you could evaluate tractors on their drawbar pull or push — a combination of engine horsepower and the amount of traction developed. These 2 dimensions — *power and traction* — gave you the necessary performance to handle clean-up around yesterday's shovels . . . let you strip topsoil and level fill, in step with the production needs of that time. Fast dozing cycles, and the ability to speed from one assignment to another, were not considered essential back in the days of lower wages and longer time limits.

But today, with larger pits, big-capacity shovels (where clean-up interruptions are costly), and the demand for higher efficiency on stripping and maintenance work, *two new dimensions* are added to your tractor requirements. These extra dimensions are *speed* and *mobility*. Bigger shovels, with high operating cost, demand that clean-up delays be kept to a minimum. Higher production demands, to meet competition, require more speed all the way . . . from stripping overburden to leveling dump areas . . . pulling or pushing scrapers . . . towing equipment, and other tractor assignments.

With the trend to bigger pits and more widely scattered operations, *mobility* must be added to speed for efficient tractor operation. To handle scattered assignments economically, your tractor must be able to run — not crawl — from job-to-job under its *own* power.

Track-type tractors can capitalize fully on two of these dimensions — power and traction. Over the years they have become so universally well-recognized that a wide selection of track-type tractors, ranging in size to 436 hp, are offered by various manufacturers.

A few of these present-day heavy track-type tractors approach the third dimension — speed — in their work range. But a big track-type tractor that successfully utilizes the fourth dimension — *mobility* — is not yet available to meet today's need.

That is why you must think today of tractors in terms of *all four dimensions* . . . power — traction — speed — and *mobility* . . . to determine which of today's tractors will give you the greatest return on your investment.

To help you in your analysis of these heavy-duty tractors, and the extent to which they can measure up to your requirements, study the information presented on the following pages which explain in detail your need for

1. POWER

2. TRACTION

3. SPEED

4. MOBILITY

Before you buy, check all four dimensions.

Dimension 1

POWER

Compare engine horsepower... but as a source, not a "force"...

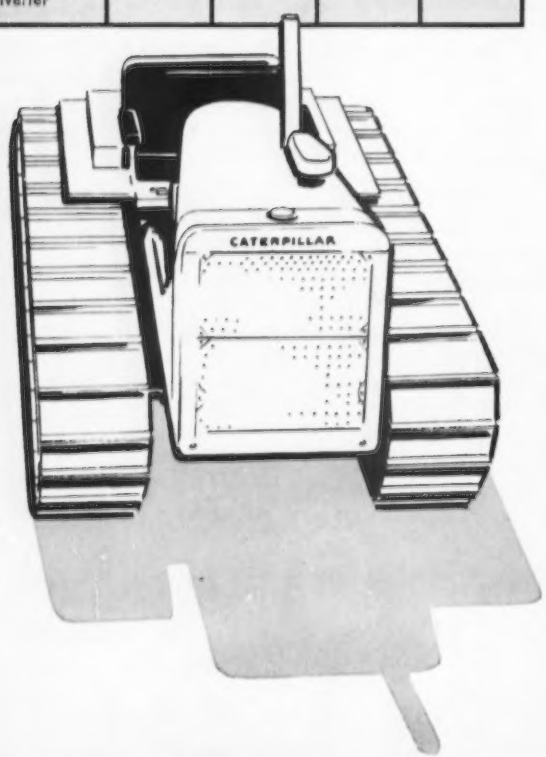
Adequate power is as important in today's pit operations as it was yesterday. It must be measured today, however, not only by its ability to "bull" a load, but by its ability to move the largest possible loads at the highest possible speeds, in the varied and scattered jobs assigned to present-day pit tractors.

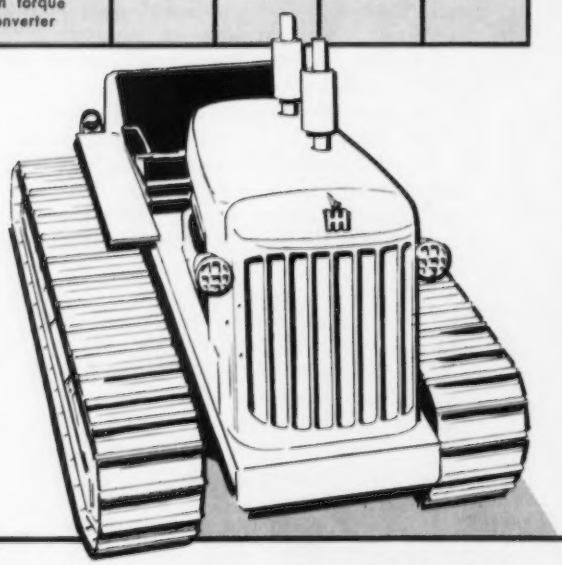
Maximum horsepower ratings alone are without meaning. Ratings must be studied across the speed range to measure your power dimension. Measure also the time and effort required for the operator to change his ratio of power application to push-pull effort or to speed effort. Check the smoothness with which power is applied, the waste in "bucking" a load. Also, the difficulties in shifting which may discourage an operator from using gear ratios to apply his power effectively.

Power at maximum "drawbar" is used little for tractive effort since, in low gear, tracks spin and power is wasted. Availability of maximum horsepower is important only in higher gears where it can be used with no slippage. *All* tractors are able to spin their tracks or wheels in low gear on normal footing . . . therefore horsepower should be considered as a power source available for use in *any direction* . . . should not be related to tractive effort alone. The most effective power combination lets the operator work at the highest practical speeds which job conditions permit.

CAT D8 191 hp with torque converter	MPH (Approx.)			
	1.5	2.0	2.5	3.0
	Pounds of pulling effort			
	30,000	24,000	18,000	15,000

IH TD24 200 hp with torque converter	MPH (Approx.)			
	1.5	2.0	2.5	3.0
	Pounds of pulling effort			
	32,500	22,500	18,000	15,000





Figures taken from manufacturers' specification sheets available to us at time of printing.

Usable pounds-pull results from many factors: type of material, conditions underfoot, weight of tractor, and forward speed, all combined have a definite effect on the pounds of drawbar pull.

From the charts, you can see that Tournatractor compares favorably with track-type tractors at today's commonly used speeds. When job conditions are adverse, use a crawler; in ordinary and favorable conditions you can put your job into high gear with rubber-

advertisement LeT

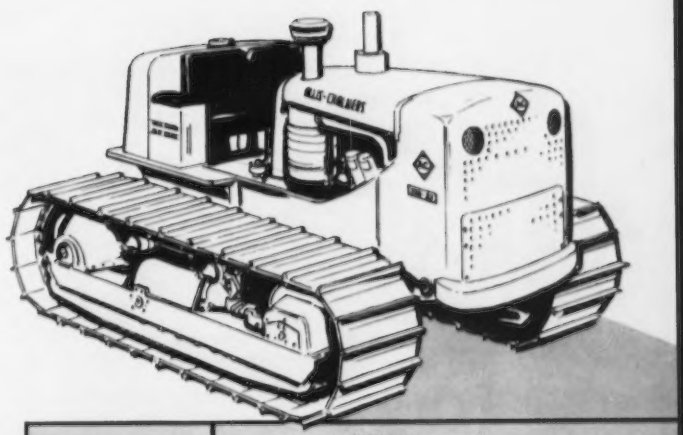
Dimension 2

TRACTION

Compare pounds pull...
but at your operating speeds...

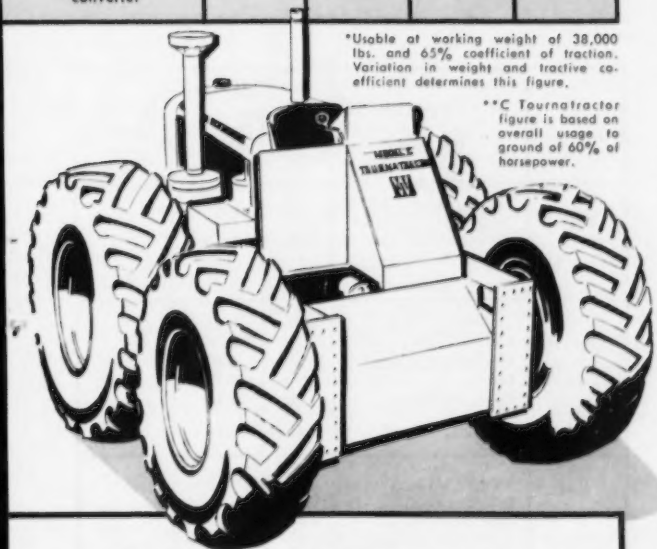
The materials you handle partially determine your choice of tractors. Track-type tractors conquer the most adverse conditions and offer tremendous traction and drawbar pull in ordinary footing. However, today's broad, deep-treaded, tapered-bead rubber tires equal track-type traction in many materials. Where traction in loose materials is a factor, the rubber-tired tractor can be given additional traction by increasing its weight. Extra weight is easily obtained with hydroflation of tires.

This flexibility of weight will pay off in providing a tractor that can utilize its speed to the fullest extent — yet add tractive effort when needed to do a wider range of heavy-duty tractor work.



LeT-WEST C** 210 hp with torque converter	MPH (Approx.)			
	1.5	2.0	2.5	3.0
	Pounds of pulling effort			
	24,700*	23,500	18,800	15,650

AC HD21 204 hp with torque converter	MPH (Approx.)			
	1.5	2.0	2.5	3.0
	Pounds of pulling effort			
	Pounds-pull curve not shown in manufacturers' literature available to us.			



*Usable at working weight of 38,000 lbs. and 65% coefficient of traction. Variation in weight and tractive coefficient determines this figure.

**C Tournatractor figure is based on overall usage to ground of 60% of horsepower.

Comparable traction of tires to tracks, in some materials, is made possible by a wide choice of tire treads. A smooth-type tire, for example, works better than tracks in sand, because it doesn't dig in. Deep lateral cross-bars are designed for rock — the tire deflects over sharp rock and the deep tread prevents damage to the carcass. Diagonal bars give maximum bite in loose materials. Tournatractor tires — 2¼ feet wide, 5¾ feet high — are of double strength nylon cord and tough rubber. Inflated with only 20 pounds pressure, the tires flex over rough ground. Continual flexing of sidewall keeps the tread areas clean for a positive bite on each tire revolution.

Crawler tracks — long and wide — have shoes of steel with deep-biting grousers. At higher speeds, much of the engine output goes to power the tracks themselves. Much of the tracks' efficiency can be lost in gummy materials, since area between grousers fills in and tracks become smooth, flat belts. Accumulated mud and dirt on tracks and rollers also reduces theoretical power applied to pulling effort.

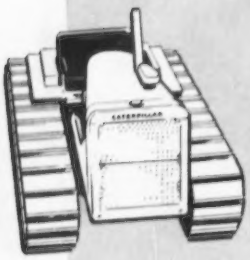
tired Tournatractor. Consider, too, how often you use all the traction available in track-type tractors. Ordinary dozing and push-loading are done in second and sometimes third gear, at speeds, ranging up to 2 miles per hour. High-speed dozing or loading with Tournatractor may require a thinner cut, but the excavated area is kept smooth, allowing faster travel of dozer and quicker entry and exit of scrapers. Too, it permits quicker return to work after wet weather.

before you buy, check all four dimensions . . . see next page

Dimension 3

SPEED

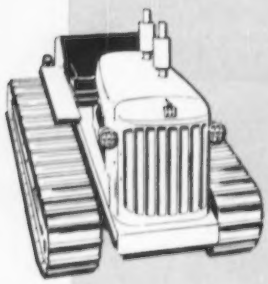
Compare speeds, and what they mean to profit...



CAT - D8

SPEEDS IN MPH

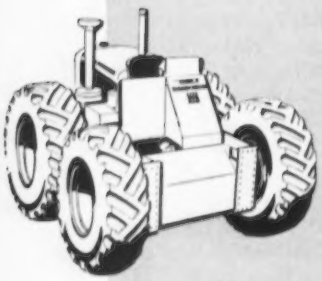
FORWARD	REVERSE
0 to 3.6 Low	0 to 3.6 Low
0 to 7.4 High	0 to 7.4 High



IH - TD24

SPEEDS IN MPH

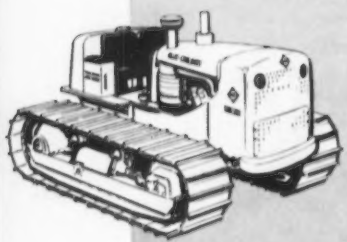
FORWARD	REVERSE
0 to 7.6	0 to 6.6



LeT-WEST C

SPEEDS IN MPH

FORWARD	REVERSE
0 to 17.2	0 to 7.2



AC - HD21

SPEEDS IN MPH

FORWARD	REVERSE
0 to 3.0 Low	0 to 5.5
0 to 7.5 High	

All above tractors equipped with torque converter. Figures taken from manufacturers' specification sheets available to us at time of printing.

Few heavy-duty tractors have kept pace with today's trend to high speed. Hauling units, loaders, shovels, scraper-combinations, and other types of pit equipment are now available on rubber for greater speed; yet most of the big tractors still roll on speed-limiting steel tracks. Habit, plus the large number of crawler-tractors still in use, make it easy to overlook the possibiilties of profit and time advantage available through use of the speed dimension. For instance, on an ordinary dozing cycle, if speed can cut your back-up time in half, you can increase the number of cycles per hour on this saving alone by 15%! Since costs remain constant, this increase in production is almost entirely profit! There is another point on speed that may be of interest. As crawler speeds are increased, and as the high gear-ranges are more extensively used, you add materially to the track-wear and overall maintenance expense.

The farther the travel distance, the more closely you should look into the advantages of rubber in the third dimension — *speed* — to increase your profits.

Work	Operation	Time (minutes)		
		Average Crawler	Rubber-Tired Tractor	Speed Saved in Min.
Dozing	Pushing load ..150 ft.	0.86	0.57	
	Return .....150 ft.	0.36	0.21	
	Gear changes	0.30	0.10	
	TOTAL	1.52	0.88	0.64
Pulling 15-yd. Scraper	Loading	0.75	1.25	
	Hauling .....1000 ft.	2.10	0.76	
	Spreading	0.40	0.40	
	Return .....1000 ft.	2.10	0.63	
	Gear changes	0.30	0.10	
	TOTAL	5.65	3.14	2.51
Push-loading	Loading	0.85	1.10	
	Return	0.42	0.21	
	Gear changes	0.30	0.10	
	TOTAL	1.57	1.41	0.16

Figures computed from manufacturers' specification sheets available to us at time of printing.

RESULT: With these minutes saved, you can doze more, haul more, do more clean-up . . . add extra profit with no extra cost.

advertisement

Dimension 4

MOBILITY

Why rubber-tired mobility means more work per shift

Only a rubber-tired tractor can readily travel from job-to-job in your pit or plant operations. It can run at speeds to 17 mph, shuttle fast between shovel clean-up and other assignments. The operator just shifts into high gear and your tractor is on its way, via haul road or across the pit floor to its next job, whether to strip overburden, level stockpiles, tow other equipment, or switch railroad cars.

Larger pit areas, and higher production requirements, make it necessary to have equipment that can move around fast and easy on its own power.

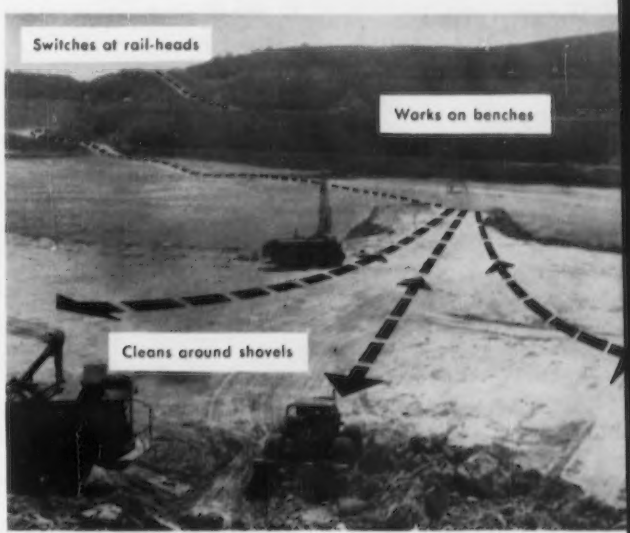
So the need for high-speed mobility is increasing each year, while the time and cost of moving track-type equipment designed for limited area work becomes higher and higher, cutting profits more and more.

In the light of these developments, it will pay you to consider the importance of *mobility* as a necessary tractor dimension in your pit operations.

Rubber-tired tractor travels at speeds up to 17 mph on work-and-run assignments. Operator can drive over pit floors, or off road. He can road his machine over tracks, ties, switches, and paving, without damage.

Tournatractor® is a modern tractor designed to take advantage of all four dimensions . . . *power, traction, speed* and *mobility*. It does not offer as much drawbar horsepower at speeds below 2 miles per hour as do track-type tractors of equal engine horsepower. But for pit operations where you *can* capitalize on the third and fourth dimensions — *speed* and *mobility* — with a machine that delivers comparable traction at present day speeds, we suggest you consider the *new* Tournatractor. The cost is 10% below that of track-type tractors with torque converters and comparable engine horsepower . . . and maintenance costs are lower.

There's a bonus-value for you in today's improved Tournatractor. A railroad coupler attachment is now available which converts this machine quickly to a practical SwitchTractor. With coupler at one end, and dozer at the other, this machine does double-duty . . . makes it an even more profitable tool for your pit operations. Your LeTourneau-Westinghouse Distributor will be happy to arrange a demonstration of a Tournatractor in your pit, to prove that its third and fourth dimensions — *speed* and *mobility* — can pay off for you. Ask him . . . or write the factory.



Sketched lines show range of rubber-tired tractor in typical mine. In foreground, tractor cleans-up around shovel. It ranges over entire pit floor for dozing, and on benches bordering the pit. Rail-head is only a few minutes drive away for switching work.

CT-1424-M

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A Subsidiary of Westinghouse Air Brake Company

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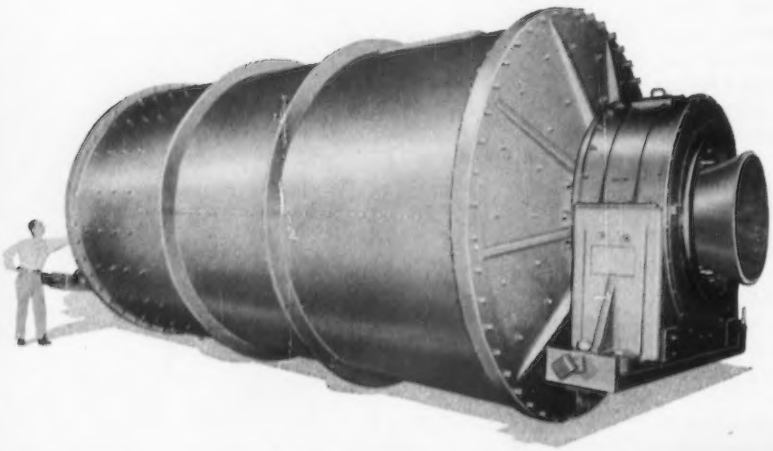

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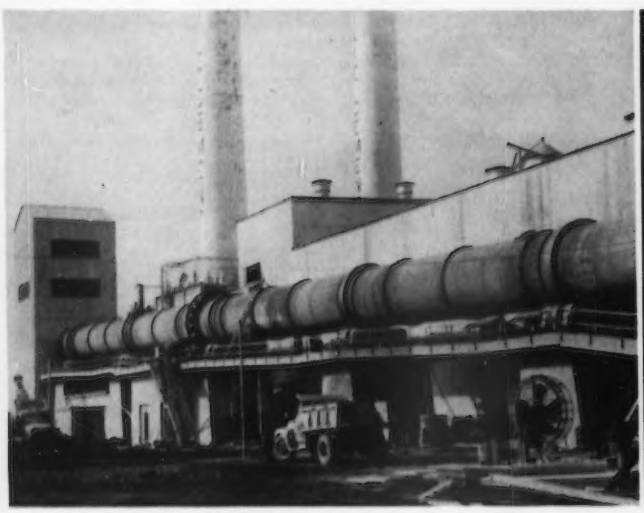

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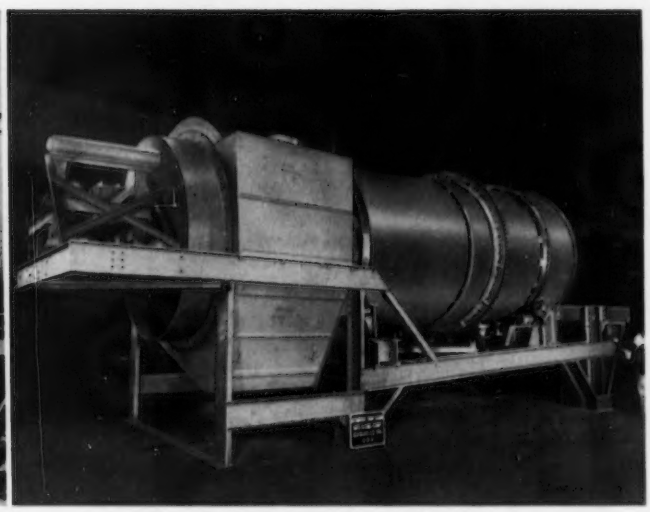

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Send for Bulletin describing KVS Machinery and Equipment.

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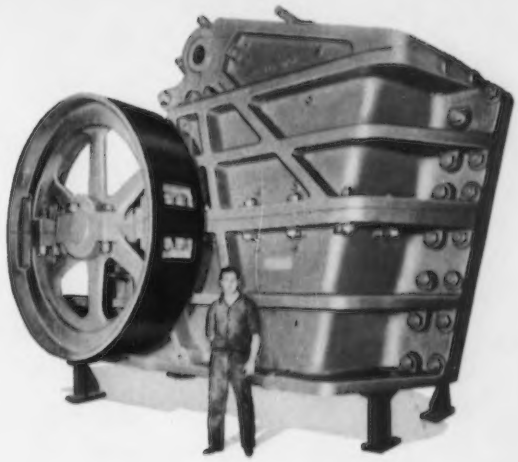
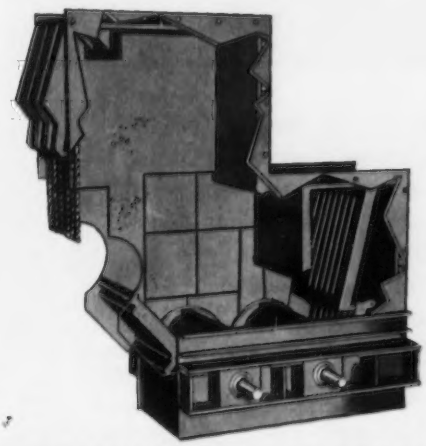
Primary and Secondary—Noted for efficiency in crushing. Wide range of sizes and capacities—V-Belt Drive or synchronous motor, built integral into pulley.



SWING JAW CRUSHER

Heavy Duty . . .Wide Range of Sizes. Jaw plates reversible. Frames of larger sizes built in four sections. Shaft cast integral with Swing Jaw. Automatic Lubrication System.



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You save money, too, because the exclusive spiral lock adds collapse strength. This permits use of lighter gauge material without sacrifice of performance.

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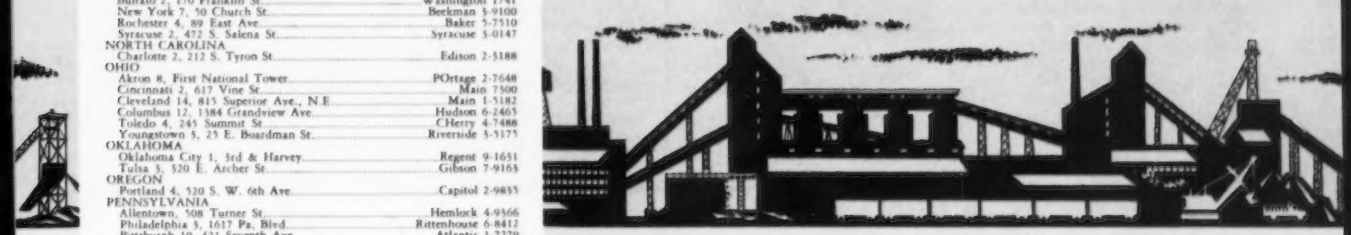

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There's no guesswork when you specify Allis-Chalmers Engineering. The A-C staff, working with your staff, analyzes your problem or process and looks for ways to make *existing* equipment "team up" with the new equipment for greater production. And the recommendation will be unbiased, because A-C builds many types and sizes of equipment. The selection will be dictated by *exactly what you need*, not an improvised arrangement.

Trained engineers in the Allis-Chalmers Research Laboratories help solve tough problems by testing samples of your product. This is another precaution to make sure that exactly the *right* equipment is selected for your particular plant.

And Allis-Chalmers not only builds the *basic* machinery, but *also* the motors, drives and control needed to run it—it is the only company that builds all this machinery in its own shops. This means a "packaged" unit or process, with every part *engineered* to work efficiently with every other . . . assures you of higher efficiencies, lower costs, undivided responsibilities. And Allis-Chalmers stands behind every unit 100%!

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25 C 7949D

VIBRATING SCREENS . . . a complete line

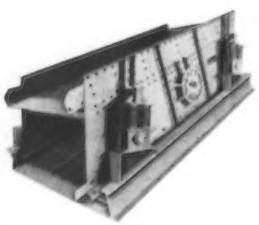
SELECTION GUIDE for metallic minerals industry

Vibrating Screen Applications	Maximum Feed Size (inches)	Aperture Range (inches)	Screen	Common Sizes (feet)
Scalping—ahead of Jaw Crushers	36	3 to 10	ROM Model XXH	5 x 10 to 6 x 14
Scalping—Following primary crushers	20	1 to 10	Model XH	4 x 5 to 6 x 16
Scalping—Following secondary crushers or hammermills	6	¼ to 5	Model SH	3 x 6 to 6 x 16
Dry Sizing	6	40 mesh to 5	Model SH	3 x 6 to 6 x 16
Dry Sizing	5	⅛ to 2½	*Low-Head*	3 x 6 to 8 x 20
Dry Sizing	4	40 mesh to 3	Model S	3 x 6 to 4 x 10
Dry Sizing	4	40 mesh to 1½	Model AVS	3 x 6 to 4 x 10
Wet Sizing and Washing	6	40 mesh to 5	Model SH	3 x 6 to 6 x 16
Wet Sizing, Washing and Dewatering	5	¼ mm to 2½	*Low-Head*	3 x 6 to 8 x 20
Wet Sizing	4	40 mesh to 3	Model S	3 x 6 to 4 x 10
Wet Sizing	4	40 mesh to 1½	Model AVS	3 x 6 to 4 x 10
Media Recovery and Washing	8	¼ mm to 2 mm	*Low-Head*	3 x 12 to 8 x 20
Thickening, Dewatering and Filtering	⅜	⅛ mm to 1 mm	*Low-Head*	3 x 12 to 8 x 20

STANDARD ALLIS-CHALMERS VIBRATING SCREENS

Model XXH ROM inclined screens

For the heaviest scalping problems



Model XXH ROM screens are of heavy steel construction with balanced, two-bearing cartridge-type mechanism. May be obtained with plate or stepped grizzly bar decks. Max. opening — 10 to 11½ inches . . . 1 or 2 decks. Send for Bulletin 07B8368.

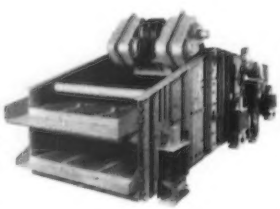
Model XH Extra Heavy Duty inclined screens

For wet or dry scalping and coarse sizing

Model XH *Ripl-Flo* screens have balanced two-bearing mechanisms and may be obtained with perforated plate, rod or stepped grizzly bar decks. Max. opening — 10 inches . . . 1, 2 or 3 decks. Send for Bulletins 07B6151 and 07B7868.

Low-Head Heavy Duty horizontal screens

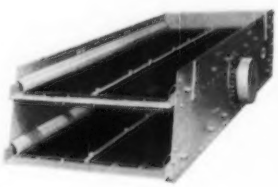
For moderate to heavy sizing, coarse to fine, wet or dry, thickening dewatering, media recovery and rinsing.



Low-Head screen operation saves headroom and space. Conveniently mounted mechanism imparts a straight line motion to screen. Max. opening—2½ inches . . . 1, 2 or 3 decks. Send for Bulletins 07B6330 and 07B7868.

Model SH Standard Heavy Duty inclined screens

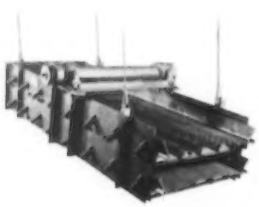
For moderate to heavy sizing, coarse to fine, wet or dry, light scalping and rinsing



Model SH *Ripl-Flo* screens have balanced, two-bearing mechanism and are designed for a wide range of applications. Max. opening—5 inches . . . 1, 2 or 3 decks. Send for Bulletins 07B6151 and 07B7868.

Model AVS Standard Duty inclined screens

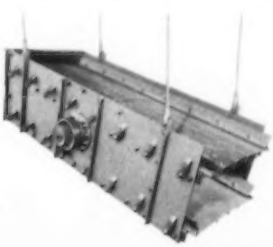
For fine sizing, wet or dry



Model AVS *Aero-Vibe* screens have two-bearing mechanism located above the body. Gives top screening efficiency at lowest possible cost. Max. opening—1½ inches . . . 1, 2 or 3 decks. Send for Bulletin 07B6099.

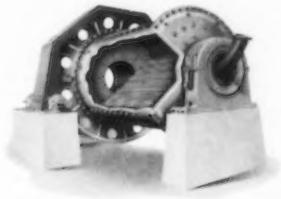
Model S Standard Duty inclined screens

For moderate, wet or dry sizing



Model S *Ripl-Flo* screens are sturdy, low cost screens . . . have two-bearing mechanism. Max. opening—3 inches . . . 1, 2 or 3 decks. Send for new Bulletin 07B8229.

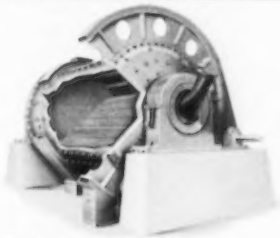
GRINDING MILLS . . . all types



Overflow Rod Mill

Sizes 3 to 11½ ft diameters, 6 to 16 ft lengths. Rod mill product can be varied from 6 to 35 mesh, with a minimum amount of fines. Because a rod mill can reduce a one inch slot size feed, it has supplanted the last stage of crushing in many plants. The screening action of the rods within the mill produces an ideal ball mill feed, free from tramp oversize, without the use of close circuiting screens.

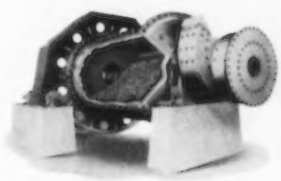
Bulletin 07B6718.



Peripheral Discharge Rod Mill

Sizes 3 to 11½ ft diameters, 6 to 16 ft lengths. The peripheral discharge rod mill was developed for those dry grinding circuits where close control is required for either the product top size or the fines. In addition to these dry grinding applications, either the end peripheral or the center peripheral discharge rod mill may be used in wet circuits where specific product requirements must be met.

Bulletin 07B6718.



Ball Mills

Sizes 3 to 13 ft diameters, 3 to 17 ft lengths. For producing a finely ground product of 28 to 325 mesh from a feed size of about ½ inch. Ball mills are unsurpassed for the fine grinding of moderately to extremely abrasive materials.

Overflow type ball mills are used for fine wet grinding in closed circuit with a classifier. Diaphragm type ball mills are universally used for fine or coarse, wet or dry grinding in closed circuit with a classifier, screen or air separator.

Bulletin 07B6718.

PYRO-PROCESSING EQUIPMENT

ROTARY KILNS . . .
For sintering, nodulizing, pelletizing, agglomerating, calcining

AIR QUENCHING GRATE COOLER

CONVERTERS

BALLING DRUMS

ROTARY COOLERS, DRYERS

HOLDING FURNACES

WASHING EQUIPMENT

CONTINUOUS CONTACT COLUMN

BLADE MILLS

LOG WASHERS

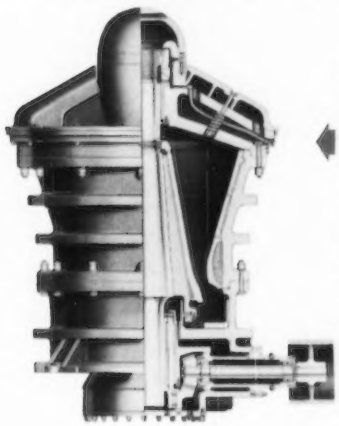
MATERIALS HANDLING EQUIPMENT

CAR SHAKERS

TRACTORS AND GRADERS

MOTOR WAGONS

CRUSHERS FOR EVERY MINING JOB



Superior Gyratory Crushers

For high capacity primary or secondary crushing

Twelve sizes . . . 16-50 to 60-109 (60 inch feed opening, 109 inch diameter cone at crushing point). Capacity 170 to 3500 tph. Available with *Hydroset* mechanism or spider suspension.

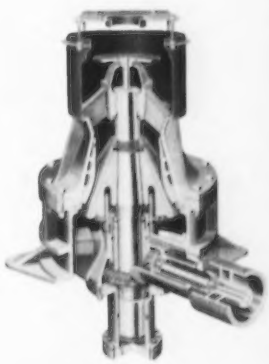
Bullein 07B7870.

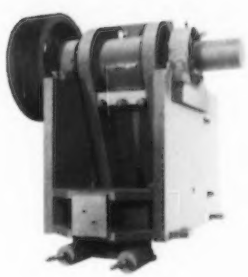
Hydrocone Gyratory Crusher

For high capacity secondary or tertiary crushing

Twenty-one sizes . . . 122 to 1784 (17 inch feed opening, 84 inch diameter cone at crushing point). Capacity 7 to 1050 tph. Equipped with *Hydroset* mechanism. Bulletin 07B7145.

The *Hydroset* mechanism adds flexibility to gyratory crushing . . . an hydraulic mainshaft support which compensates for wear, adjusts product size and facilitates clearing of crusher in case of power failure or unexpected shutdown.





A-1 Jaw Crushers

For primary crushing of tough, abrasive material in blocky feed sizes

Four sizes . . . 36x25 to 60x48 inch feed openings. Capacity, 200 to 660 tph.

Bulletin 07B6369.

Blake Jaw Crushers

For moderate capacity crushing of hard materials

Five sizes . . . 10x7 to 30x18 inch feed openings. Capacity, 6 to 90 tph. Bulletin 07B7090.

Model ST Jaw Crusher

For crushing moderately hard material with minimum fines

Five sizes . . . 18x30 to 42x54 inch feed openings. Capacity, 75 to 650 tph. Bul. 07B8595.

Fine Reduction Jaw Crusher

For crushing 7 inch and smaller feed to 50% passing ¼ inch in one operation

Two sizes . . . 18x9 and 24x10 inch feed openings.

Bulletin 07B6425.

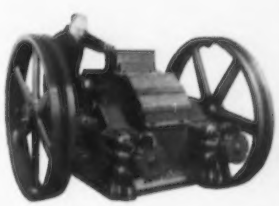
Roll Crushers

For fine crushing of hard material with minimum fines

Double-roll crushers are driven by large flywheel sheaves. Roll diameters from 9 to 78 inches. Bulletin 07B6180.

For crushing large tonnages of laminar rock

Single roll *Fairmount* crushers, two sizes . . . 24x84 and 36x60 inch rolls. Write for more information.

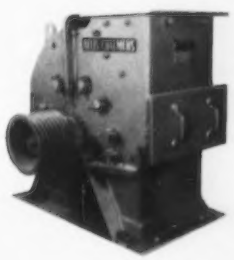


Pulverator Hammermill

For pulverating non-abrasive materials

Hammers reduce material by multi-impact . . . large ratio of reduction. Handles up to 4 inch feed. Five sizes . . . capacity 2½ to 125 tph.

Send for Bulletin 07B6265.



A DRIVE FOR EVERY MACHINE

***Texrope*—greatest name in V-belt power transmission—is the registered trademark of Allis-Chalmers, originator and pioneer of multiple V-belt drives.**

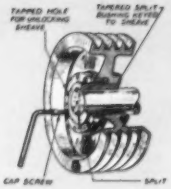
Ask for Bulletin 20C6051, "Handy Guide to Selection of *Texrope* Drive Equipment"; it tells the complete *Texrope* Drive story . . . V-belts . . . sheaves . . . and how to figure a *Texrope* drive.

Grommet Belt

Wide Range Belt

Texrope V-belts

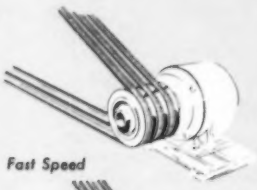
Famous patented grommet construction provides longer life than ordinary V-belts. Made with straight sides for greater grip. Types for all operating conditions: heat-resisting; oil-resisting; static-resisting and special High Capacity. Also available: *Texrope* wide range V-belts for use with wide range *Vari-Pitch* sheaves and *Vari-Pitch* Speed Changers.



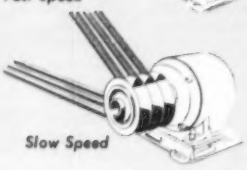
Magic-Grip Sheaves

The *Magic-Grip* cast iron sheave provides fast, easy mounting and demounting. Construction is simple, foolproof. Sheave automatically adjusts itself to slightly oversize or undersize shaft. Positive clamp fit on shaft means no weaving—no vibration. There is no back lash—no extra play. Sheave can be mounted closer to motor or machine—reducing strain and stress. Result: bearing pressure eased—bearing life increased.

Stock sizes for drives up to 200 hp. Larger sizes available on order.



Fast Speed



Slow Speed

Vari-Pitch Sheaves and Speed Changers

VARI-PITCH SHEAVES are available in two types; Standard Range for A, B, C, D or E belts—capacities from 1 to 300 hp—speed variations up to 40%. Wide Range for Q and R belts—capacities from 1½ to 40 hp—speed variations up to 100%. Both types designed with stationary or motion control features—Stationary Control for infrequent changes when sheave is stopped; Motion Control for repeated speed changes while sheave is in motion.

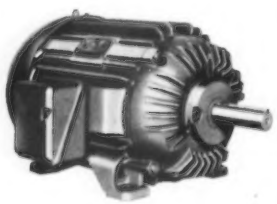
Vari-Pitch Speed Changers furnish 3¾ to 1 speed ratio in one compact, enclosed unit. Adjustable while in motion. Combines two wide range, worm gear-adjusted sheaves. Manual or pushbutton control.

MOTORS FOR EVERY DRIVE

Allis-Chalmers builds a *complete* line of polyphase squirrel cage, wound rotor, synchronous, and direct current motors with electrical and mechanical modifications to meet *any application*. Ask for Bulletin 51C6052, "Handy Guide for Quick Selection of Electric Motors"; it furnishes you with enough facts on Allis-Chalmers motors to enable you to select the type which meets your required electrical and mechanical specifications. The next time you need an electric motor, contact your nearby Allis-Chalmers representative.

Drip-Proof

Small, tough, general purpose squirrel cage motors. All-around protection of inner parts. ½ to 200 hp and up. Also in splash-proof types. Bulletins 51B6210 and 51B7693.



Enclosed Fan-Cooled

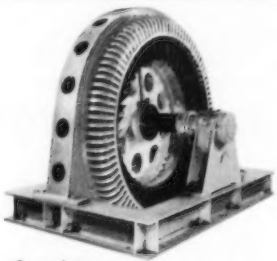
Protected from dust, grit, vapor, gases. Cooling air circulated around exterior. ½ to 100 hp. Bulletin 51B7225. Also in new tube cooled type to 3000 hp.

Large Induction

Drip-proof or splash-proof. 60 hp at 300 rpm to 200 hp at 1800 rpm. Bulletins 05B7542. Pedestal bearing types, 05B7771.

Wound Rotor

For adjustable varying speed service. High starting torque, low starting current. Bulletins 51B-6052 and 05R8183.



Synchronous

High torque motors of constant speed, available in ratings of 40 hp and larger. End shield bearing, pedestal bearing and engine types.

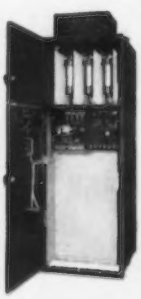
Weather-Protected

Design simplicity and the ability to operate under the most severe weather conditions are combined in this weather protected motor. Sizes from 250 hp up.

Bulletin 5188606.

CONTROL FOR EVERY MOTOR

Allis-Chalmers makes a line of starters to meet practically all motor control needs. Count on this wide range of starters, backed by industry-wide application engineering experience, for the answer to your control needs. Ask for Bulletin 1487733.



Power Distribution

Allis-Chalmers also supplies a complete line of power distribution equipment to mining plants. This includes power, distribution, and instrument transformers; indoor and outdoor switchgear and unit substations; circuit breakers; power rectifiers.

Tractor Equipment

Allis-Chalmers has geared its development progress to the earth moving and material handling needs of the mining industry and is supplying crawler tractors, tractor shovels, pull scrapers, motor scrapers, motor wagons, motor graders, and power units.

ALLIS-CHALMERS

969 South 70th Street, Milwaukee 1, Wisconsin

LITHO IN USA D&J

Exploration Drilling

HERE IS A QUICK RUN-DOWN of modern drilling practice from the relatively simple step of racking core to the more complex problems of handling overburden. This is not even close to being a text book, but rather a guide or memorandum to the driller and exploration engineer, covering the problems encountered in modern drilling and a few answers to those problems.

Included also is an up-to-date check chart of the drills available for exploration and what they can do for you.

Get the Best Value from Drillhole Samples

VERNON READ

ALTHOUGH THE TREND is toward laying core in a box in book fashion, starting at the top lefthand corner as in reading a book, this is not universal. Some core is still logged in "snake" fashion, from left to right in the top groove, right to left in the second groove, and so on. A third system is to start at the top righthand corner and to lay the core in the reverse of book fashion. Any system can be employed provided it is clearly noted. The main thing is uniformity on the job.

Most core boxes are designed to hold 25 ft of core in five grooves, each 5 ft 1 in. long. They are usually made of wood. New lightweight aluminum core boxes have proved very useful where everything has to be flown in to the drill site.

Although there is a demand for all core to be stored indefinitely (the U. S. Bureau of Mines maintains regional core storage facilities where core is stored free of charge provided shipping costs are paid in advance) most exploration companies will have neither the time nor the facilities to do this. On most jobs only the more important sections, particularly those sent for assay, are retained. In some districts, notably the Northwest Territories, all assessment work core must be left for inspection by the Mining Recorder.

St. Joseph Lead Co., Jones & Laughlin Ore Co. and other companies have all core photographed in color, thus retaining a useful core library in minimum space.

Sludge Samples

Wherever there is the slightest suspicion of some of the softer values in a core being ground up into sludge, samples of the sludge should be assayed and checked against the corresponding core assay. If the values should be in soft material, then the sludge assay will prove higher than the core assay. Should any consistent difference be noted, sludge samples should be taken along with core samples. The Cerro de Pasco Corp. in Peru and the San Manuel Mining Co. in New Mexico, drilling massive copper sulphide deposits, use both large diameter churn drilling collecting sludge samples, and core drilling to ensure the most representative samples for assay.

Good sludge recovery requires standard bit dimensions drilling a uniform size hole with no dilution of the cuttings due to caving of the drillhole; if there should be caving, the hole must be cased. It is important to check that all cuttings are brought out of the hole. This is done by checking the percentage of water return. Also check that there is adequate water velocity to raise all the cuttings and that no sulphides or heavy material stick to the rod grease.

Massive copper deposits at Cerro de Pasco are sampled with BX holes (2⅜-in. hole diameter by 1⅛-in. core diameter) to depths of 2,000 ft. Forty foot rod pulls are made using light aluminum derricks. Non-rotating, self-sealing double tube core barrels are preferred for coring; sludge samples are taken wherever ordinary double tube barrels are used. The casing is kept within 30 ft of the bit, reaming out the hole after each rod pull.

Special emphasis is placed upon returning over 80% of the drillwater used for a run. The drillwater is measured by weight using settling tanks 1.6m high and 1.22m diameter with a conical bottom containing a spigot to draw off the sludge. Each drill has two tanks for alternate drilling runs.

All cores are weighed to establish core recovery. Both core and sludge assays are used in determining the drillhole assay, weighing them as follows:

$$\text{Drillhole assay} = \frac{X\,(\%\ \text{Cu}) + Y\,(\%\ \text{recovery})\,(\%\ \text{Cu})}{X + Y\ (\%\ \text{recovery})}$$

Where X = weight of core assay,
Y = weight of sludge assay.

Mr. Read is exploration engineer with Columbia Iron Mining Co. at Provo, Utah.

Reducing Vibration in the Drill String

TO ACHIEVE GREATER STABILITY in drill strings, less damaging vibration and consequently reduced caving of the hole, greater water passage between the rod couplings, and a reduced number of coupling threads to speed connecting of the rods, the Diamond Core Drill Manufacturers Association established "research standards" of the "U" Series drill rods. These rods are designed to provide a more efficient relationship between the diameter of the rods and the diameter of the drillhole: the area of the space between the rods and the hole wall being 14% of the area of the hole. New threads specifications give a pitch of three threads per inch.

In field testing, these rods have realized all the advantages listed above. In addition, the 29-deg slope thread makes for a tighter joint and minimizes leakage; it is also self-centering, providing a straighter section of rods and coupling and consequently reduced vibration of the drill string. Some danger of uncoupling of the rods in the drill hole was anticipated in the early tests, but, after thousands of feet drilled at depths of more than 2,000 ft, no such uncoupling has occurred.

Vibration in drill rods is also being reduced by the development of self-centering chucks and by the use of fluid couplings and torque converters. These by absorbing shock loads and torsional vibration from the engine help eliminate strain and hence wear on the drill string.

Both fluid couplings and torque converters will adsorb shock loads and torsional vibration. The fluid coupling transmits an output torque equal to the input torque with a small loss for slip, resulting in an efficiency of 95 to 98%. No special heat exchangers are necessary to carry off this small energy slip loss.

On the other hand the torsue converter may have an output torque more than six times the input torque with a corresponding reduction in speed. Thus the torque converter acts as a

geared transmission with infinitely varying gear ratio within the design range. The average torque converter operates at an efficiency of about 80% and requires a heat exchanger to carry away the energy loss. Although experience has been limited to isolated applications, present torque converters are not recommended for drill motors because the automatic torque multiplication would increase the danger of damage to equipment should the drill string become stuck in the hole.

Where separate power sources for drilling and hoisting are justified, the use of fluid coupling plus gear transmission in the drilling equipment and the use of a torque converter with or without gear transmission in the hoisting equipment should materially reduce the maintenance and breakdown time of a drill rig while greatly increasing its life.

Mud Fluids for Difficult Drilling

FIRST USED in rotary oil drilling about 1901, mud fluids are now finding important applications in mineral drilling to penetrate overburden and to improve core recovery in difficult, unconsolidated formations.

Basically, mud fluid contains clay, preferably Bentonite, with a high proportion of colloidal material and water that is fluid when agitated but turns to jelly upon standing. Its functions in drilling include:

1. Removal of cuttings—the viscosity of the mud fluid reduces particle slip, thus lowering the upward velocities required, and if the pumps are stopped for any reason the gelling of the mud locks the particles in place in the hole and prevents them from sinking around and freezing the bit. Once out of the hole the cutting particles are removed from the mud fluid on vibrating screens, having 0.011-in. rectangular openings.

2. Cooling and lubrication of the bit and drill rods—the presence of a slick, low resistance film on the rods and the walls of the hole facilitates pulling of the rods, without the use of rod grease.

3. Wall plastering action and prevention of wall caving—the weight of mud fluid in a hole helps hold in place weak walls that would otherwise contract or cave. This wall supporting action is augmented by increasing the specific gravity of the mud. Moreover, the fluids plaster the wall of the hole with a mud cake since the liquid portion of the mud column is forced into the fine, porous wall rocks leaving the solids of the mud on the wall as a dewatered semi-hard layer. Careful mud control is essential to keep the wall cake impervious and thin enough not to obstruct the drill hole.

4. Preventing water influx—ground water can be kept out of the drillhole by using mud fluids of adequate weight. The hydrostatic head of the mud column can be increased as necessary by increasing the proportion of clay solids up to about 75 lb per cu ft.

5. Mud fluid jetting action—a mud fluid emerging from the bit openings at high pressures helps cut rock by its jetting action ahead of the bit. In soft formations this jet can do more digging than the bit in many cases.

6. Casing eliminated—by control of caving, mud fluids can materially reduce the amount of casing required for a hole, considerably reducing costs.

7. Improved core recovery — by eliminating caving and by depositing a protecting film over the core in the barrel, mud fluids help improve core recovery. In the tar-bearing sands of northern Alberta, a core recovery averaging 95% was achieved using mud fluids where core recovery was negligible using regular drill water.

For drilling a BX size hole through overburden using mud fluids, most operators recommend a fluid having a Marsh funnel viscosity of 40 to 60 sec. Mud fluid circulation is from 5 to 8 gpm at the lowest possible pressure, under 50 psi unless the hole is unusually deep. Excessive pressure causes unnecessary loss of mud fluid which may be expensive. A 200-gal. tank is used and viscosity is checked hourly.

(*Continued on p 22*)

Light Reconnaissance

Drill	Manufacturer	Capacity (feet)	Diameter (inches) Hole	Core	Power[1]
Penndrill "E"	Pennsylvania Drilling Co.	50	1½	1¼	1.5 E
Mighty Midget	Houston Tool Co.	100	1¼	—	9 hp, G
Havlick Uranium	J. L. Havlick	100	1⅜	¾	5½ hp, G
Packsack	Packsack Diamond Drills, Ltd.	100	1¼	⅞	5½ hp, G
Super Pioneer	Diamond Drill Contracting Co.	100	1⅜	1⅜ST ¾DT	5 hp, G
Hossfield	Hossfield Mfg. Co.	110	2⅝	—	6 hp, G
DL-874s	Lovequist Engineering Co.	150 EX	—	½	2½ hp, E
DL-875s	Lovequist Engineering Co.	—	—	—	1 hp, E
Acker RGT-SK	Acker Drill Co.	150 200	2½ 2	1⅜	6 hp, G
X-ray XR XRT	Boyles Bros. Drilling Co., Ltd.	200	1⅜	¾	7 hp, G
Porta	Canadian Longyear, Ltd.	200 XRT	1⅜	¾	3½ hp, G
Prospector	E. J. Longyear Co.	300	1½	1⅜	6 hp, G
Drill Scout	Gustafson Mfg. Co., Inc.	200	—	½	6 or 9 hp, G
Holeycat	Atomic Engineering Corp.	300	1⅜	⅝	6.6 hp, G

[1] Power: G-Gasoline; E-Electric; D-Diesel

For address of drill manufacturers, see Manufacturers' Directory in the Buyers'

Portable Rock Drills

Drill	Manufacturer	Type	Power	Capacity (feet)	Diameter (inches)	Weight (lb)	Angle of holes	Cost
Cobra	Atlas Copco.	Piston	Gasoline	13	—	53	Down and up to 45 deg	—
Demo	Demo Tool Corp.	Rotary core	Electric, 880-w	100	1¼	50 excl. generator	Down and up to 45 deg	—
Homelite	Homelite Div. of Textron Inc.	Rotary, high cycle electric motor	2500-w gasoline engine generator	20	—	Generator, 125; Drill, 65; blower, 20	Any angle (jackleg available)	$1,370
Hossfield	Hossfield Mfg. Co.	Piston	Gasoline, 7½ hp	110	2⅝	1,300 with 70-ft steel	Down only	$950
DL 375S	Lovequist Engineering Co.	Piston	Electric, ⅝ hp	4	3	7	Down	$216
Pinazza	Pitnam Indl. Products Co.	Centrifugally actuated rotary percussion	3½- to 5½-hp gasengine or electric motor drives through flexible shaft	16½	—	Drill 37 to 51; power unit 165 to 180	Any direction	$1,200
Pionjar	Stanco Mfg. & Sales, Inc.	Piston	Gasoline, 2½ hp	13	—	86 and 66	Down and up to 45 deg	$930
Super Pioneer	Diamond Drill Contracting Co.	Rotary, diamond	Gasoline, 5 hp	150	1⅜	Drill 35; pump, 35	Any angle	$835
Syntron	Syntron Power Tool Co.	Piston	Gasoline	10	—	118	Down only	—
Warsop	Warsop Power Tools Ltd.	Piston	Gasoline, 2½ hp	13	—	90	Down and up to 45 deg	$650

Drills (to 300 ft)

Transmission	Feed	Length of feed (inches)	Core barrel	Hoist	Derrick max. rod pull (feet)	Bit speed (rpm)	Mount	Weight (pounds)	Cost
Direct	Rack and Pinion	30	Single tube	None	—	250 to 290	Skid	300	$697
Direct	Manual	30	Double tube	None	—	300 to 600	Pack frame	125	$1,750
Direct	Manual	30	Single and double tube	None	None	2,400	Column on grouted pipe	Drill and col. 72, pump 49	$890
Direct	Manual	24	Single tube	None	None	1,500	Hand-held	Drill 32, pump 48	$750 with pump
Direct	Manual	24	Single and double tube	None	None	1,250	Hand-held	Drill 35, pump 35	$835 with pump
Belt and chain	Screw	—	—	None	None	Slow	Tires	1,260	$1,192
Direct	Manual	—	—	None	None	900	Hand-held	45	$967
Direct	Manual	—	—	None	None	900	Hand-held	37	$942
Reducer	Manual	24	Single and double tube	Cathead	10	350	Skid or trailer	675	$1,500
Direct, 2-speed	Screw	14	Single and double tube	None	None	300 to 500	Skid	190 with integral pump	$1,235 with pump
Direct	Screw	14	Single and double tube	None	None	to 1,250	Skid	260 with integral pump	$1,310 with pump
3-speed	Screw, hydr.	20	Single and double tube	Spool	10	1,650	Skid	600	$2,420
—	—	—	Single tube	Spool	6	500	Trailer	1,000 with pump	—
—	Hydraulic	60	Single and double tube	Hydraulic	—	2,400	—	300 with mud tank	$2,950

Guide in this issue

Medium Exploration

Drill	Manufacturer	Capacity (feet)	Diameter (inches) Hole	Core	Power[1]	Transmission	Feed[2]
P-350	Houston Tool Co.	350	4¼	—	30 hp	4-speed	C
Teredo LD	Acker Drill Co., Inc.	400 EX	—	—	5 hp, G	3-speed	M
Model "B" Testborer	Pennsylvania Drilling Co.	450 AX	1⅞	1⅝	38 hp, G	4-speed	H
S&H L-2	Sprague & Henwood, Inc.	500 EX	1½	⅞	10 hp, G	V-belt	S
Schramm 75	Schramm, Inc.	500	4¼	—	Pneumotractor	5-speed	H
CP-55	Chicago Pneumatic Tool Co.	500	1½	⅞	A	None	S
S&H 30	Sprague & Henwood, Inc.	600 EX	1½	⅞	12 hp, G or D	3-speed	S, H
Drill Scout	Gustafson Mfg. Co., Inc.	650 AX	3	2⅛	129 hp, G	Direct	H
Schramm 76	Schramm, Inc.	700	6¼	—	G, D or P	5-speed	H
"24"	E. J. Longyear Co.	750	1½	13/16	G, D, E or A	3-speed	S, H
Teredo TH	Acker Drill Co., Inc.	800 AX	—	⅞	18 hp, G or D	3-speed	S, H
CP-8	Chicago Pneumatic Tool Co.	1,000 AX	—	1⅛	25 hp, G or D	4-speed	S, H
S&H 40-C	Sprague & Henwood, Inc.	1,000 EX	1½	⅞	24 hp, G or D	4-speed	S, H
NXO Hydraulic	Diamond Drill Contracting Co.	1,000 NX	2 15/16	2⅛	31 hp	4-speed	H
CFD-1 Combination	George E. Failing Co.	1,000	2⅜	—	P, min. 140 hp	4-speed	H
Mayhew 1,000	Mayhew Supply Co., Inc.	1,000	3½	—	—	3-speed	R
CP-12	Chicago Pneumatic Tool Co.	1,000	1½	⅞	A	Gear	S, H
Penndrill JE	Pennsylvania Drilling Co.	1,000 EX	1½	⅞	24 G or D	4-speed	S, H
BBS-1	Boyles Bros. Drilling Co., Ltd.	1,200 EX	—	—	25 hp	4-speed	S
Junior Straitline	E. J. Longyear Co.	1,350	1½	13/16	E, G, D or A	4-speed	S, H
1500 Combination	George E. Failing Co.	1,500	2⅜	—	P, min. 140 hp	4-speed	H
BHD-C	Winter-Weiss Co.	1,500	8	—	P, G or D	3-speed	R
CP-15	Chicago Pneumatic Tool Co.	1,800 AX	—	1⅛	45 hp, G, 35 hp, D	4-speed	S, H
UG Straitline	E. J. Longyear Co.	2,000	1½	13/16	E, G or D	4-speed	S, H
S&H 142	Sprague & Henwood, Inc.	2,000 EX	1½	⅞	30 hp, G, or D	4-speed	S, H
AX Hydraulic or Screw	Diamond Drill Contracting Co.	2,000 AX	1⅞	1⅛	31 hp	4-speed	S, H
Penndrill H	Pennsylvania Drilling Co.	2,000 EX	1½	⅞	30 G or D	4-speed	S, H

[1]Power: G-Gasoline; E-Electric; D-Diesel; A-Air; P-Power takeoff
[2] Feed: S-Screw; H-Hydraulic; R-Rotary table; C-Chain and cable; M-Manual

Lost circulation can be recovered by pumping in 100 to 200 gal of very thick mud containing 1 to 2% Epsom salts or cement. This increases the gelling properties of the mud and on standing for half an hour will usually seal off the zone of lost circulation. When drilling is resumed, use a lightweight mud that will not disturb the seal.

One operator reports that using mud fluids to drill NX casing through 200 ft of overburden to bedrock averaged about four times as fast as driving pipe under the same conditions

Drills (300 to 2,000 ft)

Length of feed (inches)	Hoist	Derrick, max. rod pull	Bit speed (rpm)	Mount	Weight (pounds)	Cost
15	2-drum	5 ton	0-600	Self propelled	—	—
24	Cathead	Vertical	900	Skid, truck or trailer	500	$ 1,222
72	Drum	15 ft	1,100	Trailer, truck	4,900	$ 5,460
20	Drum	—	1,000	Skid, truck or trailer	1,400	—
144	—	15 ft	28-148	Pneumo-tractor	16,500	$12,365
24	Air rod	—	0-2500	Column	160 (drill only)	—
S-20, H-30	Drum	1,400	—	Skid, truck or trailer	1,350	—
67	Drum	5 ft	200	Skid, truck or trailer	1,200	$ 2,250
300	Drum	20½ ft	48-172	Truck	41,500	$25,800
S-20, H-18	Drum	20 ft	228 to 2,200	Skid or jeep	995	—
24	Cathead	—	900	Skid, truck or trailer	2,300	$ 3,000
S-18, H-24	Drum	—	1,050	Skid	G-1,650; D-2,400	—
S-20, H-30	Drum	—	1,400	Skid, truck or trailer	1,850	—
24	Drum	—	1,350	Skid	3,400	$ 5,500
30	—	Vertical	72 to 220	Truck, min. base 157 in.	22,000	$20,000
—	Drum	31-22 ton	50 to 325	All	—	—
18	Drum	—	0-1500	Double column	800 with col.	—
S-20, H-24	Drum	20 ft	1,500	Skid, jeep, trailer	2,000	—
24	—	—	1,000	Skid, truck or trailer	1,145	$ 4,873
S-20, H-18 to 30	Drum	20 ft	—	Skid or trailer	1,700	—
30	Drum	Vertical	40 to 214	Truck, min. base 175 in.	—	$21,500
—	Drum	Vertical	50 to 250	Truck, skid or trailer	—	—
S-18, H-24	Drum	—	1,500	Skid	G-2,300; D-3,000	—
S-20, H-30	Drum	20 ft	—	Skid or truck	2,200	—
S-20, H-30	Drum	—	1,200	Skid, truck or trailer	3,300	—
24	Drum	—	1,250	Skid	3,250	$ 5,150
S-20, H-24, 30	Drum	20 ft	1,200	Skid, truck	3,400	—

and proved considerably more economical.

Mud fluids lose their effectiveness when used as a cure. They do a much better job if used from the start of a hole as a trouble preventative. After using mud to support the walls of a hole, never change over to water without first setting casing, otherwise the mud walls will collapse.

Drilling Water— How Much Is Needed?

DIAMOND DRILLING requires adequate water to insure that the bit is cooled and lubricated, to carry off the cuttings from the bottom of the drillhole and to keep the core from sticking in the core barrel. The pressure and volume of water needed must be enough to produce a velocity of 12 to 18 in. per sec moving up around the drill string. Using EX rods, this requires 120 gph. AX 200 gal, BX 430 gal, and for an NX drillhole using A size rods, 1400 gph. Water pressure needed is 50 to 150 psi for EX, AX and BX drillholes; and from 200 psi for NX holes down to a depth of 1,000 ft up to 600 psi to 4,000 ft.

The above figures of drilling water requirements are standard where water is plentiful. Minimum water needs are from 40 to 70 gph for drillhole sizes E to N respectively; where only 50% water recovery is obtained these volumes should be increased to 80 to 100 gph and where no water is recovered they should be increased to 200 to 350 gph. Drilling water can be recirculated to the drillhole provided that sludge is first separated out in settling tanks.

The supply of such volumes of water may be difficult in bush country, particularly in winter, and water sources should be checked before starting any drilling campaign. A water line over 2,000 ft long is troublesome and may require extra strong hose to withstand the pressures involved. Sometimes a sump can be blasted in swamp or low ground to make a pit 10 ft dia and 5 ft deep that will provide enough water for EX or AX drilling.

Two pumps are usually used in surface drilling, one at the water source pumping water into a sump or drum at the drill, and a second pump, sometimes integral with the drill, to give water pressure for drilling. Brush pumps are driven by a small gasoline engines, skid mounted, and can be changed from a low volume, high pressure unit to a high volume, low pressure unit and vice versa by switching the drive gearing ratio. For winter operations, drill water is heated in drum heaters, either wood or oil fired. An oil fired heater weighing 475 lb gives a 50-deg F temperature rise to 300 gph water for a fuel consumption of 1 to 1½ gph of fuel oil.

Where a large volume of water must be pumped continuously in subzero temperatures, friction heat may

be used to compensate for radiated heat by speeding up the water flow velocity. For 1-in. pipe at temperatures down to 40 deg F below zero, a minimum flow velocity of 3 fpm is required. At the Francoeur Gold Mines, Ltd., 15 gpm is pumped through 2,000 ft of line with no artificial heat whatsoever by using flow velocities of 5 to 6 fps at minus 40 deg F temperatures. If you depend on friction, watch the line closely.

Six Ways To Beat Overburden Problems

MANY DRILLHOLES have had to be abandoned before reaching bedrock because of difficulties in penetrating overburden. Normal practice where the anticipated overburden is less than 50 ft deep is to drive a BX or NX casing string faced by a diamond casing bit. If the ground is hard or boulders are encountered, the hole is first driven with the smaller coring bit and later reamed out with the casing bit. Care must be taken that the casing is driven firmly into bedrock; if it is not firm, vibration of the rods may loosen the casing and the hole might have to be redrilled.

Standard casing rods and casing bits are expensive and are not recommended for deep overburden where there may be a possibility of not being able to withdraw the tools on completion of the hole. Drive-piping is cheaper than wrought iron or steel pipe. For caving ground some operators favor a low cost casing shoe bit as a one-shot tool that can be abandoned in the hole.

In heavy overburden up to 200 ft thick, standard practice is to drive 3-in. pipe as far as it will go then continue 2-in. pipe into bedrock. AX bits (but not casing) will pass through 2-in. pipe and EX bits through 1½-in. pipe. If the overburden is expected to be over 200 ft deep it is good practice to start with 4½- or 5-in. pipe. To assist in driving down the pipe, wash rods are driven about 3 to 5 ft ahead, using 1-in. rods for 2½-in. and 2-in. rods for 5-in. piping.

A fishtail bit is effective in silt, sand, clay and hardpan that is free of boulders. Quicksand should be drained of its contained water before attempting to drill.

Boulders can be carefully drilled through or blasted. Electric blasting is used, with 1 to 3 halfsticks of 60% dynamite. Before firing, the casing is pulled up from 5 to 10 ft. Driving is recommended immediately after the blast, before the loose rock has a chance to settle. If excessive caving is encountered, the walls of a drillhole may be strengthened by using mud fluids, a technique long used in oil drilling (see page 20). At the Canadian Wright Hargreaves Mine, two holes were cased to bedrock at 258 ft and 352 ft by the use of mud after standard piping had become prohibitive at depths of only 120 ft and 58 ft.

Although mud drilling through overburden may be expensive, up to $5 or $10 per foot, it may often be the only choice short of abandoning a drillhole and losing the tools in it.

FAULTED GROUND and caved old workings are drilling problems at Moa Bay Mining Co.'s El Cobre prospect, Cuba.

If mud has to be used, it should be resorted to as early as possible, to avoid getting tools stuck fast in heavy overburden.

Freezing is another technique for penetrating difficult overburden. Instead of the usual water, chilled kerosene at temperatures from minus 10 to minus 50 deg F is used as the drilling fluid to freeze the moisture in the material being drilled. This technique was developed by John D. Bardill at the U. S. Bureau of Mines using dry ice as the refrigerating medium. The chilled kerosene is circulated in a closed circuit system using insulated storage and settling tanks where rock cuttings, sand and ice are

Heavy Exploration

Drill	Manufacturer	Capacity (feet)	Diameter (inches) Hole	Core	Power[1]	Transmission	Feed
Mayhew 2000	Mayhew Supply Co., Inc.	2,000	3½	—	G or D	4-speed	Rotary table
Acker No. 65	Acker Drill Co.	2,200 to 3,500	1⅞ to 3	1⅛ to 2⅛	G, D or E	4-speed	Hydraulic
BBS-2	Boyles Bros. Drilling Co., Ltd.	2,400 AXT	1⅞	1⅜	70 hp, G or D	5-speed	Screw hydraulic
Failing 2500	George E. Failing Co.	2,500	3½	—	G or D	4-speed	Rotary table
Mayhew 3000	Mayhew Supply Co., Inc.	3,000	3½	—	150 hp, G or D	4-speed	Rotary table
Longyear 44	E. J. Longyear Co.	4,000	1⅞	1⅛	51 to 59 hp, G, D, E or A	4-speed	Twin hydraulic
Master Straitline	E. J. Longyear Co.	4,250	1 15/16	1⅜	50 hp, G, D or E	4-speed	Hydraulic

[1] Power: G-Gasoline; E-Electric; D-Diesel; A-Air

removed from the kerosene before recirculating it. Drilling speeds must be kept low enough to ensure adequate freezing of the material being drilled. Rock or gravel containing as low as 3% water can be drilled by this method.

On a freezing job in New York State, a three-man crew drilled through 88 ft of sand, gravel and boulders, then 3½ ft into bedrock and set BX casing, all within 10 hr at a cost of $2.25 per ft. Kerosene loss was 2 gal per ft with a dry ice consumption of 2500 lb. Cost breakdown, excluding transportation of supplies:

Dry ice 2500 lb.	75.00
Kerosene, 200 gal.	28.00
Drill bit wear	45.00
Labor	50.00
Other supplies	5.00
Total	$203.00

Freezing operations require certain precautions: (1) any internal combustion engines must be placed in a well-ventilated spot where they will not be stopped by the carbon dioxide fumes from the evaporating dry ice; (2) chilled kerosene must be kept circulating continuously until the drillhole is cased; and (3) if the frozen core is to be logged, this should be done at once, or the core packed in dry ice to keep it frozen.

Morisette Expansion Reamer is a useful tool for penetrating coarse sand or shifting boulder beds. This is a special concave, non-coring bit that can be put down through the casing to drill ahead of it. As the bit drills, three diamond set lugs expand on the bit to ream a hole slightly larger than the flush-joint casing. The casing is kept turning with a pipe wrench to follow the expansion reamer to within 1½ in. The reamer is withdrawn by simply raising the rods, thus disengaging the lugs which collapse against the pilot tube. In one case after a 3-in. extra heavy pipe had stuck at a depth of 194 ft, two successive sizes of these expansion reamers carried the hole to ledge at 400 ft.

Larson Ledge Finder is another useful tool. It's a combination of a non-coring bit set 1½ in. ahead of a casing show bit. Both are slowly rotated together at about 100 to 200 rpm. This is a secondary tool used after standard standpipe has been driven at least halfway to bedrock.

Wedging—A Useful Tool for Deep Drilling

DEFLECTION WEDGES can be employed to make a controlled change in the direction of a drillhole of up to 1½ deg per wedging (sometimes called whipstocking) operation in from one to five shifts depending on the depth and the technique employed. Controlled deflections are useful to recover a second vein intersection; to sidetrack past abandoned tools or any other obstruction; to reach inaccessible locations; or simply to keep a hole on line.

A great deal of wedging is employed in the South African Goldfields to obtain several reef intersections from one deep drillhole, often at depths of six to seven thousand feet. Thus the core samples are considerably more representative of the values in the reef. For instance, a drillhole has been bottomed at 6,605 ft, then three more cuts of the reef taken using the Hall-Rowe method. These cuts required an additional 420 ft of drilling and were completed in one month from bottoming the initial drillhole.

Either a permanent (one-shot) or retrievable-type of wedge may be used to deflect a drillhole, but the retrievable wedge is favored due to its efficiency and over-all economy. Examples of the most common deflecting wedges:

Hall-Rowe Deflecting Wedge: The drillhole is usually plugged about 8 ft below the location of the proposed deflection. This may be done by filling the hole with drift sand, crushed rock, a wooden plug which is split diagonally to wedge the plug in the hole, or a removable steel expanding plug with a tapered mandril. The steel plug is placed very quickly as it is only necessary to lower the plug at the end of the drill string and to apply water pressure. Above it is placed a 36-in. wooden plug, then a spade end wedge attached to the rod line by three ⅜-in. copper rivets. These rivets shear when pressure is applied to the rods thus leaving the rods free for retraction. The deflecting wedge is then oriented by checking the lowest point in an etch on a clinometer tube and the wedge adjusted in the hole as required. Drilling past the wedge is done with a non-coring pilot bit for the first 5 ft, using a short core barrel, no longer than 10 ft. Afterwards the hole is reamed to full size and coring continued with regular equipment.

Thompson Wedge: This retrievable wedge is reported to be very rapid, taking only three to seven hours. It consists of a gravity tube containing a lead segment which causes the tube to rotate to the low side in a drillhole, and thus orients a tapered concave steel deflecting wedge ready for drilling past the deflection without any surveying of the drillhole. Using a pilot bit the hole is reamed out and drilling continued in the usual manner. This equipment appears to be efficient in angle holes to a dip of about 70 deg, in steeper holes the lead segment has less tendency to seek the low side of the hole.

A core-fisher cannot be used after wedging since there is a danger of it catching in the wedge. Any core left in the hole should be chopped and washed out.

Drills (over 2,000 ft)

Length of feed (inches)	Hoist	Derrick max. rod pull	Bit speed (rpm)	Mount	Weight (pounds)
—	Drum	58 to 30 ton	50 to 300	Skid, trailer or truck	—
24	Drum, 4-speed	20 to 30 ft	188 to 1,200	Skid or truck	4,500
—	—	30 ft	2,000	Skid	3,000
—	Drum	58 to 45 ton	—	Truck	—
—	Drum	85 to 50 ton	—	Trailer	—
24	Drum, 4-speed	—	1,200	Skid, trailer or truck	4,500
18 to 30	Drum	—	—	Skid or truck	7,200

Airborne Exploration

NON-CONDUCTORS (High Tension Pinned)				CONDUCTORS (High Tension Thrown)				
Sp. G.	Magnetic	Weakly Magnetic	Non Magnetic	Highly Magnetic	Magnetic	Weakly Magnetic	Non Magnetic	Specific Gravity
Over 8.0							Gold Copper	Over 8.0
8.0						Tantalite		8.0
7.5							Galena	7.5
7.0					Ferberite	Wolframite	Cassiterite Wulfenite	7.0
6.5								6.5
6.0			Scheelite					6.0
5.5						Samarskite		5.5
5.0	Monazite	Bastnasite		Magnetite		Columbite Hematite Franklinite	Pyrite	5.0
4.5	Xenotime		Zircon Barite	Ilmenite— (High Iron)	Ilmenite Davidite	Euxenite Chromite	Molybdenite Koppite	4.5
4.0	Garnet Siderite Staurolite		Perovskite Corundum Celestite			Ilvaite Marmatite	Rutile Chalcopyrite Brookite Sphalerite	4.0
3.5		Epidote Olivine Hornblende Apatite Tourmaline	Kyanite Diamond Topaz Sphene Sillimanite Fluorite				Acmite Augite	3.5
3.0		Mica (Biotite)	Anhydrite Mica (Muscovite) Beryl Feldspars Calcite Quartz					3.0
2.5			Gypsum Chrysotile Sulphur				Graphite	2.5
2.0								2.0
Under 2.0								Under 2.0

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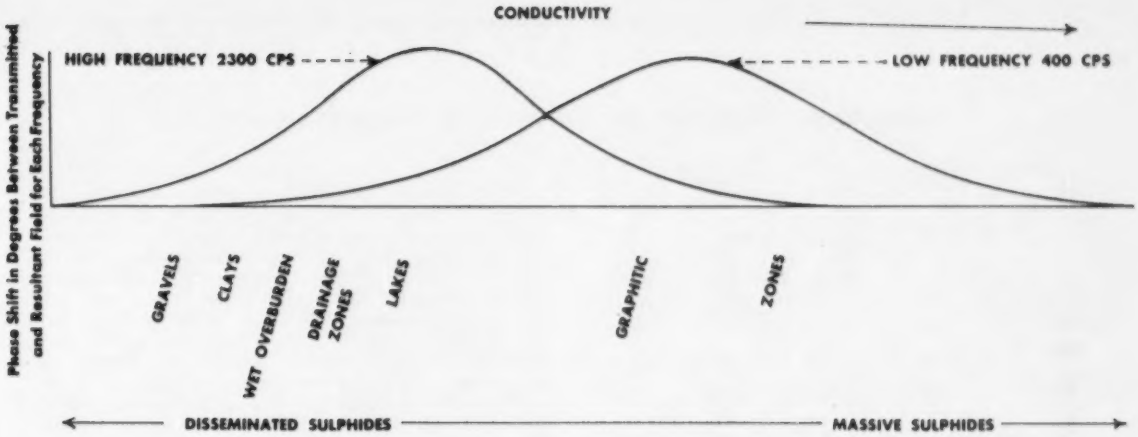
These Characteristics Aid Mineral Detection

When we took a look at the table above, which Carpco Engineering Co. was kind enough to let us use in the metallurgical section, it occurred to us that this kind of information would be just as handy to the exploration man who is making use of today's geophysical tools. After all, geophysics is merely the application of physics to the earth science and this table gives the important physical properties of minerals.

In simplest terms, the minerals on the right, the conductors, can be distinguished by electrical or electromagnetic methods. Further distinction can be made on both sides of the table by checking magnetic susceptibility, and further pinpointing is possible by gravimetric methods according to specific gravity indicated for each mineral. The conductivity table is expanded on the next page. Use both as a guide to choosing geophysical methods.



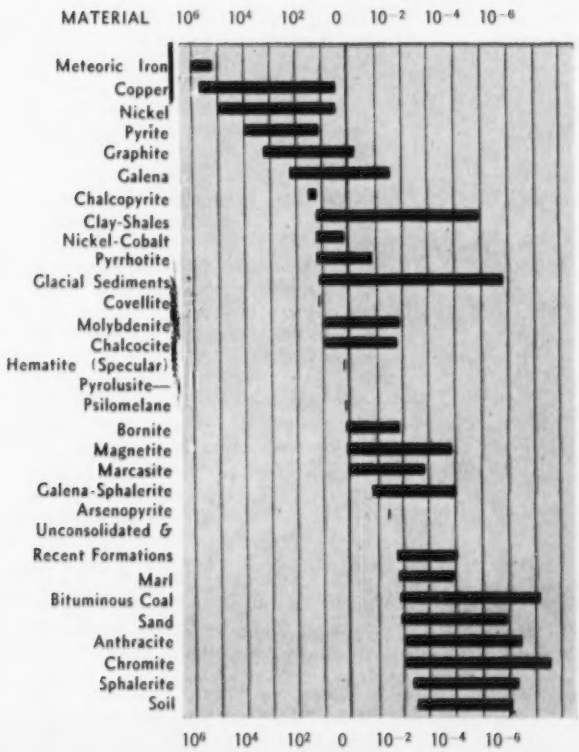
Airborne Electromagnetic Method Speeds Prospecting

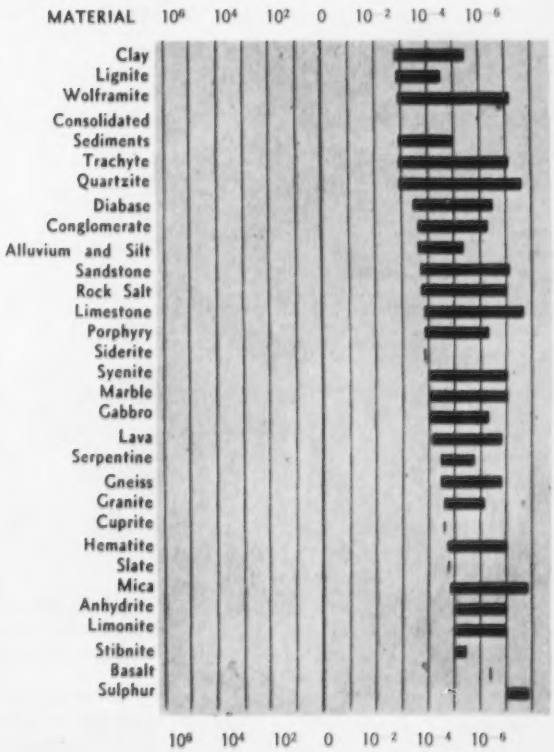
AIRBORNE ELECTROMAGNETIC prospecting gives a lot of information fast, particularly when used in conjunction with other airborne geophysical techniques. Here's how Aeromagnetic Surveys, Ltd., does the job.

Both low and high frequency fields, transmitted from the plane, set up their respective resultant fields depending on the conductivity of the ground below formation. Phase shift between the transmitted field and the resultant field is measured for both frequencies. Degree of phase shift is indicative of conductivity of material in the geologic formation as shown by curves above. Key to finding where you are on the curves is the ratio of low frequency phase shift to high frequency phase shift. A high reading in a single frequency could mean almost anything but the ratio of the two frequencies pins down the answer and effectively extends the range of the method. Values of the phase shift are purely relative.

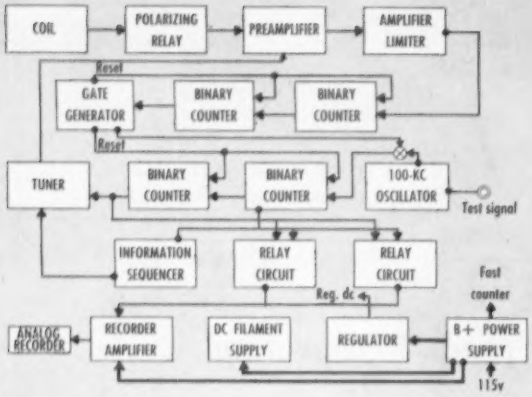
In practice, both fields are transmitted by coils mounted between the wing tips and the stabilizer of the plane. Resultant fields are picked up by coils in a trailing "bird" flown 200 ft above the surface Penetration of the earth is about 300 ft.

Conductivity of Geological Materials





Schematic Diagram of Precession Magnetometer

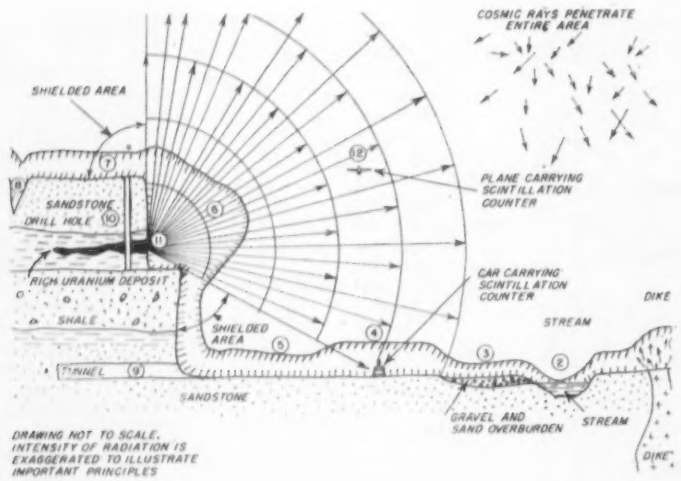


Initially current through the coil set in a bottle of water polarizes the water. When current is turned off, protons in water tend to align with earth's field. This causes each spinning proton to wobble (precession) which induces a voltage in the coil. Frequency of precession and induced voltage are proportional to earth's field. Signal from coil, now acting as detector, is fed to a narrow band amplifier which transforms it to essentially a square wave. This enters the binary counters of the Slow Counter. The binaries and gate generator set a time interval corresponding to say 512 cycles of precession frequency. During this time interval an ultrastable high frequency oscillator transmits to binaries of the Fast Counter. This total count, proportional to the period of precession signal is a measure of the earth's field. The count is recorded in analog form on a convenient scale for interpretation.

Airborne Magnetometer Aids Geologic Mapping

WHILE MAGNETITE, titaniferous magnetite and some forms of pyrrhotite and hematite can be located directly with the airborne magnetometer, its chief value is as an aid to geologic mapping. The aeromagnetic map can be correlated with known geology and ore occurrences and used to find new ore. Definition of contact metamorphic deposits, intrusive boundaries, shear zones, faults and minor fractions are all mappable. Association of magnetic minerals with ore can help locate drill sites.

There are several magnetometers on the market (see Buyers' Guide). Described above is one of the newer types, developed by Varian Associates and used by Hycon Aerial Surveys, Inc. in the United States and elsewhere.



Radioactivity Detection

IN DETECTING RADIOACTIVITY, the airplane is fastest and can reach areas inaccessible by foot or car. Drawing above illustrates detection principles. Shading along surface indicates slight radioactivity that emanates from all rock exposures.

(1) A dike containing minute but higher than average quantities of radioactive minerals increases the count.

(2) A stream decreases the count because it acts as a very effective shield to radiation from below.

(3) Sand and gravel act as a shield to a lesser degree.

(4) Normal surface count is increased by radiation from uranium deposit in cliff.

(5) Area is shielded by corner of cliff.

(6) Radiation from exposed uranium deposit sends count way up.

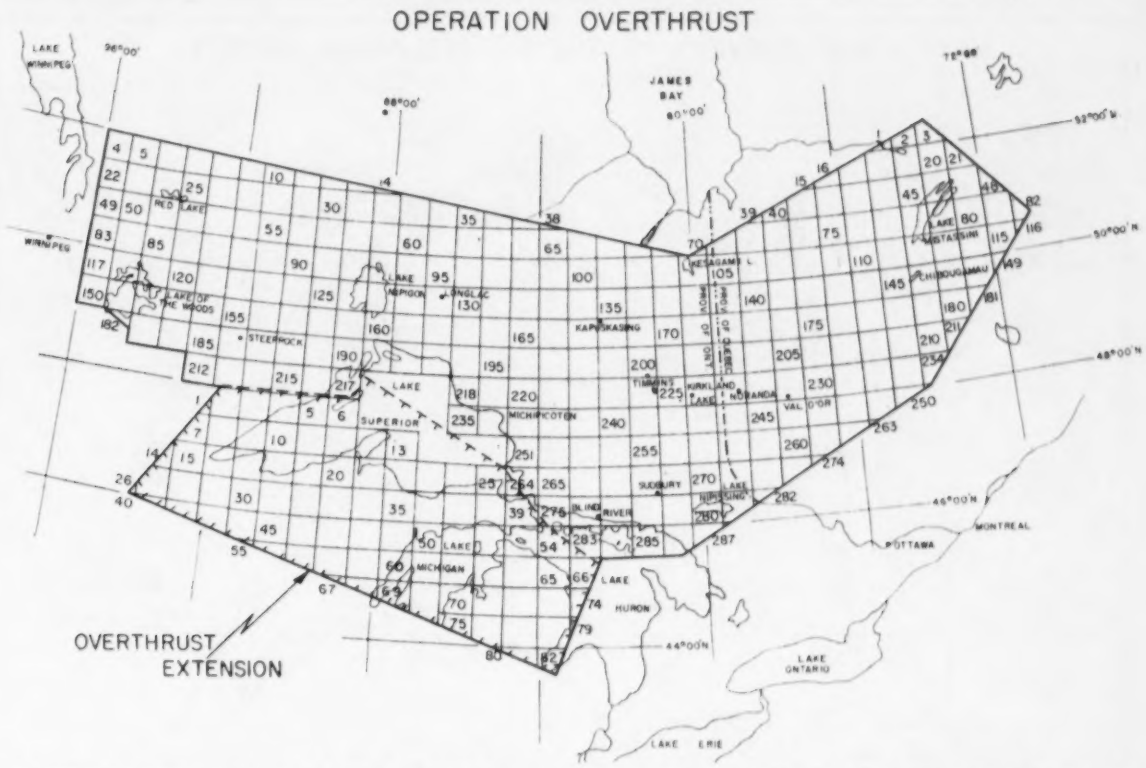
(7) Overlying sandstone shields uranium deposit.

(8) (9) Cosmic radiation bombards entire surface but will add less to background count in ravine and tunnel.

(10) Probe in drill hole would pick up radiation at the orebody.

(12) Radiation from ore face **(11)** decreases in intensity as it travels through space but could be detected by scintillation counter in plane.

Excerpted from "Prospecting for Atomic Minerals," Knoerr and Lutjen, McGraw-Hill Book Co.



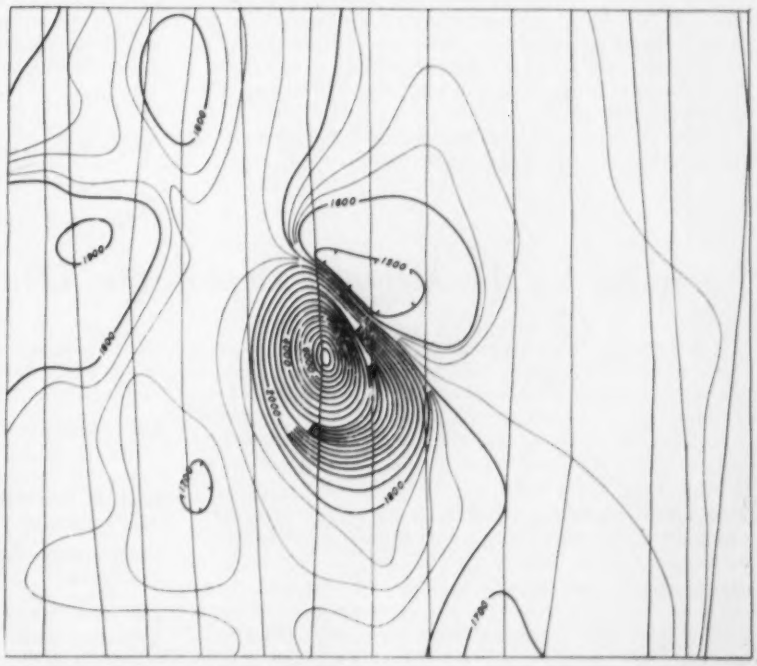
PHOTOGEOLOGY will correlate all geologic and geophysical data in this area 1,200 miles long and up to 500 miles wide with photo interpretation. 369 mosaic sheets will be produced.

Two Examples of the Role of Airborne Exploration

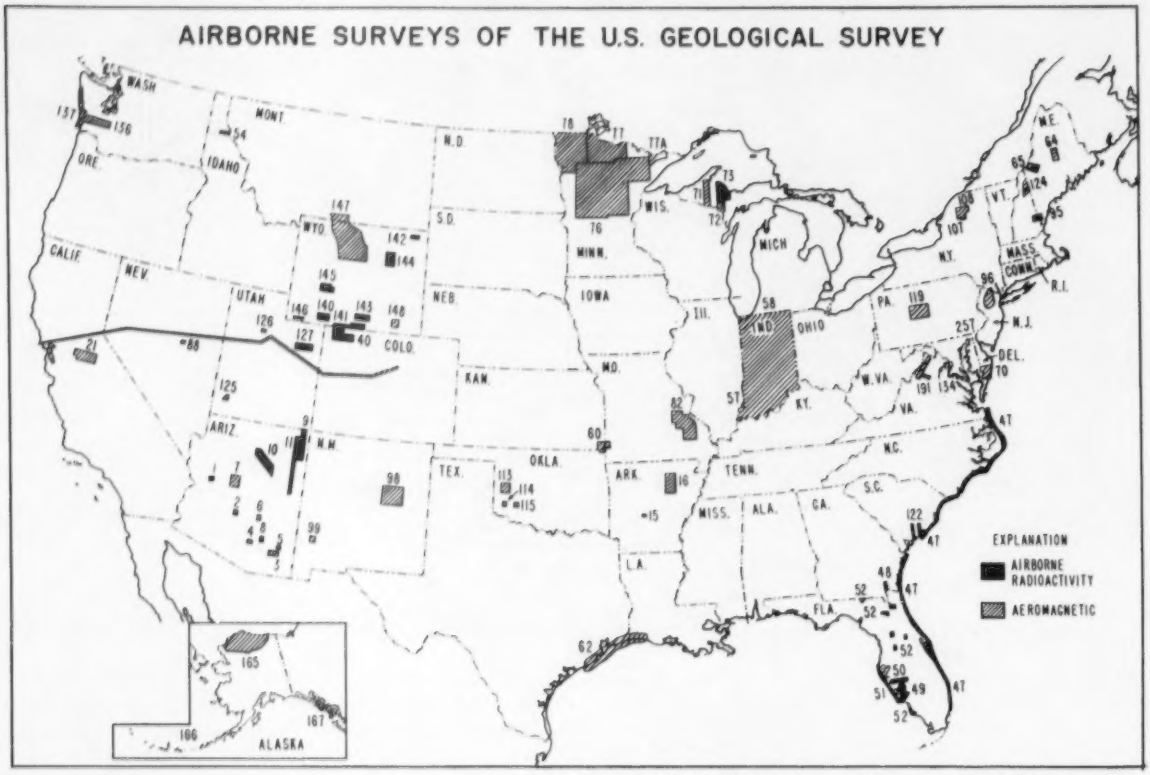
"OVERTHRUST" is the correlation by Photographic Survey Corp., Ltd., of *all known existing and available geological and geophysical data* with structural evaluation of some 357,000 sq miles of Pre-Cambrian shield by stereo-interpretation of air photographs over the entire area.

Results will include one-mile-to-the-inch mosaic sheets (287 for Canada, 87 for U.S. as noted on map above) showing structure, fracture patterns and contact zones obtained by stereoscopic study. With preliminary work underwritten by PSC, the information is available for a fee to a limited number of subscribers.

Discovery of the Marmora magnetite mine of Bethlehem Steel Co. in Ontario was largely due to 1,450-sq mile aeromagnetic survey conducted by the Geological Survey of Canada and the Ontario Department of Mines. Resulting geomagnetic maps showed several interesting anomalies. Subsequent drilling by Bethlehem proved up the mine at Marmora.



BLIND DISCOVERY of a magnetite orebody was made by the analysis of a geomagnetic map available from the Canadian or Ontario Government for 25c.



This information is available through the courtesy of the U. S. Geological Survey.

What the Government Has Done

RESULTS OF AIRBORNE magnetic and radioactivity surveys flown by the U. S. Geological Survey are available to the public. Areas surveyed are shown on the accompanying index map. They are listed alphabetically by state and carry an index number that identifies each area on the map. This report lists the surveys available as of April 1, 1957.

These surveys have been released by publication in the Geophysical investigations series maps, which may be purchased; by publication in professional journals, which are carried by many libraries; or by open filing, which means they may be viewed at certain offices of the Geological Survey, or State Surveys, or universities.

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Summing Up the Airborne Exploration Effort

TO FLY OVER a potential mineral area and bring back a mass of unrelated figures may look impressive, yet mean absolutely nothing. According to Hunting Geophysics Ltd., London, you can make certain that an area has been conscientiously investigated and data accurately interpreted by obtaining the following records which can be picked simultaneously in the flight.

Positioning photographs taken continuously and automatically during flight relate the readings of the instruments to locations on the ground.

Radio altimeter readings are an automatic check that your property has been flown at the correct height. This is particularly important when flying over rough country.

Radioactivity count is a continuous record that may help to explain the geology of the area and bring to light radioactive deposits worthy of closer investigation.

High Frequency Electromagnetic record shows better response to the lower range of conductors such as lakes, wet overburden and disseminated orebodies.

Low frequency electromagnetic record shows better response to the high range of conductors such as sulphides and graphites and also has greater depth penetration than the high frequency. Comparison with the high frequency results provides a useful clue to the nature of the find.

Magnetometer record shows variations in the earth's magnetic field.

The final picture is given by looking at all results. Low frequency results can be contoured and the ratio of low frequency to high frequency readings is added at anomaly peaks. A high ratio denotes areas of conductivity warranting further investigation.

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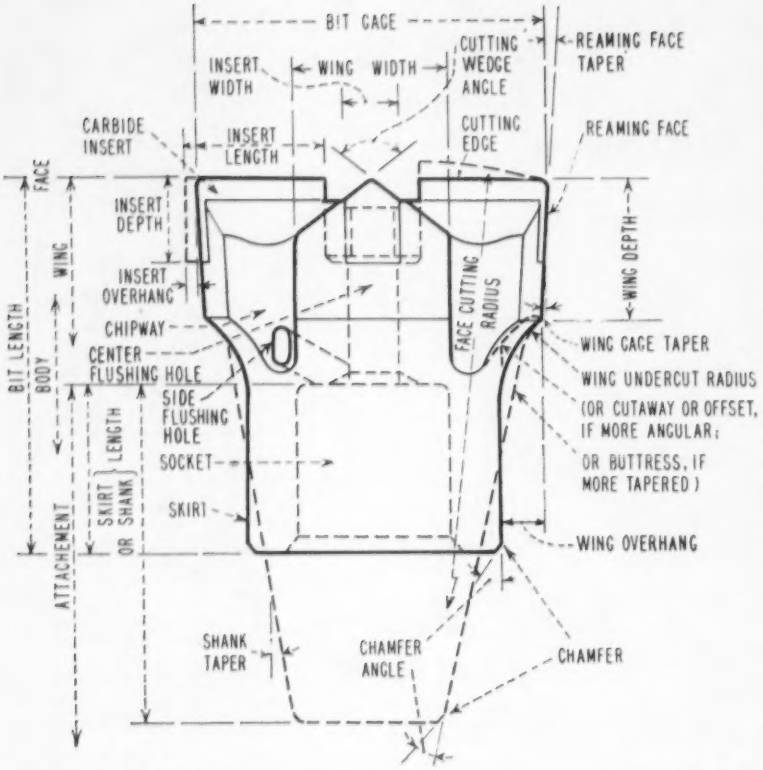
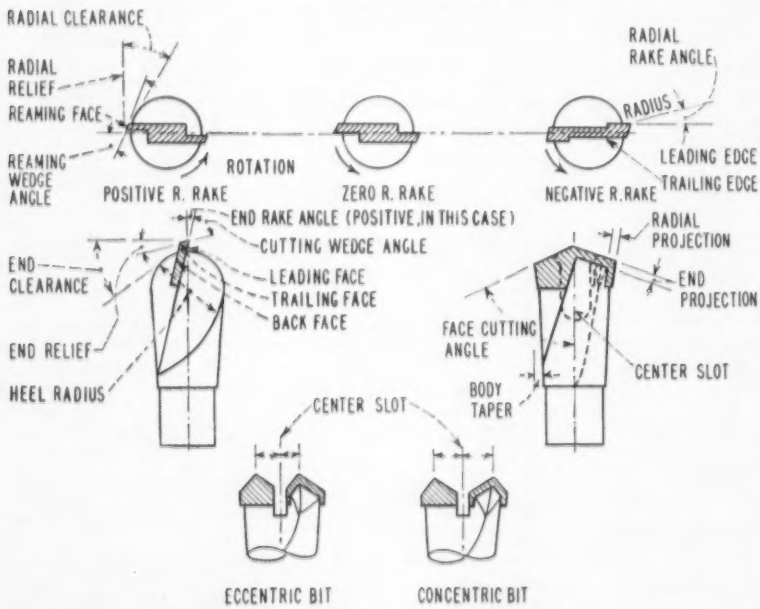
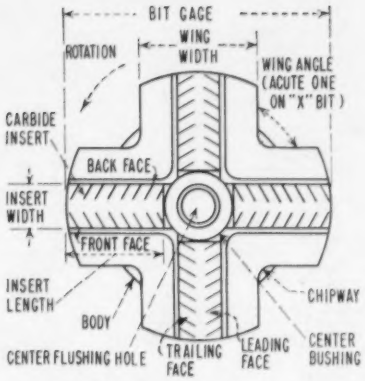
Mining's Aim for Greater Productivity



STANDARD BIT NOMENCLATURE based upon descriptive terms used in various manufacturer's catalogs, technical articles and Government publications. Bit nomenclature published in *E&MJ's* 1957 Mining Guidebook have been revised to conform to modern usage.



STANDARD BIT NOMENCLATURE for rotary types of rock bits. All bits can be given the same basic nomenclature, but rotary types have more elements to consider. Introduction of tungsten carbide bit elements accounts for great increase in interest in rotary bits now applied to harder types of rock.



ADDITIONAL standard bit terms are defined in this end view of a bit.

Bit Nomenclature

ON THE FOLLOWING PAGES you will see numerous designs of rock bits by various manufacturers for open-pit and underground drilling. Many of the details of bit design shown on this page are extremely critical. Such elements as "reaming edge taper" may make all the difference in the world as to whether a rock bit will continue to penetrate to the bottom of the hole, or whether the bit will bind and cause a "stuck steel." If the bit is of the slip-on type, the socket and skirt design becomes an equally critical detail.

In the same way, the cutting-edge angle is of acute importance. If the angle is too obtuse, the bit acts as a hammer and not a cutting tool. This imposes heavy shock on the drill and the steel. If the angle is too acute, bit edges will fail prematurely, and bits costs will soar.

Sometimes introduction of a new type of drill will cause manufacturers to take an entirely new look at bit design. This applies to the rotary percussive bit which must exert a sort of gouging action along with the usual chisel action.

Your Comments Invited

Because bit manufacturers will be stressing these design details in their literature, it is important for the reader to know what these detailed bit elements are and what they are called. The standard bit nomenclature presented in *E&MJ's* 1956 Mining Guidebook is brought up to date in this Guidebook. Modifications conform to current usage. If you have any comment or criticism to offer, the editors will welcome it.

Starts with the Rock Bit

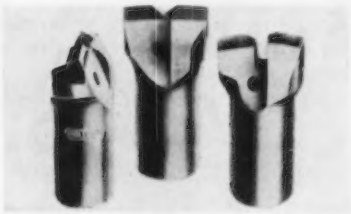
CONTINUING HIGH LABOR COSTS and mounting equipment and material costs are applying inescapable pressure on management to increase productivity of labor. Mine management everywhere will tell you that the worker of today is not increasing his efforts to boost productivity. It's only the machine and the application of power that makes economic mining a possibility in these days of declining ore grades and greater metallurgical problems.

Every detail in the flowsheet of metal production from the tip of the bit to the casting wheel has to be re-examined to see whether some improvement can be introduced to increase performance or output, even if such increase be measured in terms of only a few per cent. Actually the benefit attained by adopting new methods and equipment may be substantial. One of the contributors of information to this section on mining cites a case history where output per man was increased by 14 tons per man-shift as the result of adoption of a new type of tungsten-carbide bit.

The following pages on open-pit and underground mining are aimed at aiding the reader to review new ideas and equipment which can increase productivity in the mine.

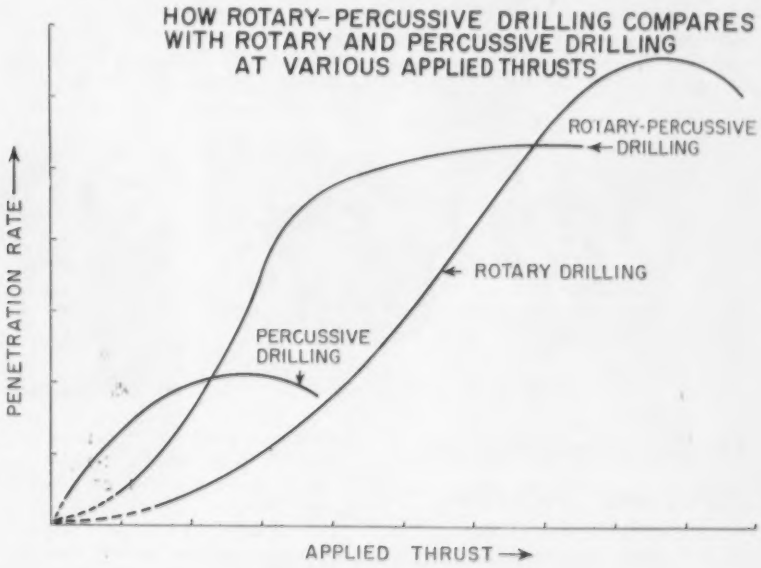
Some of the subjects which were covered comprehensively in the 1956 Mining Guidebook such as jumbos, rock drill types, etc. are not repeated in this Mining Guidebook. Material presented in this Mining Guidebook is intended to complement and up-date the subjects presented in the 1954, 1955 and 1956 issues.

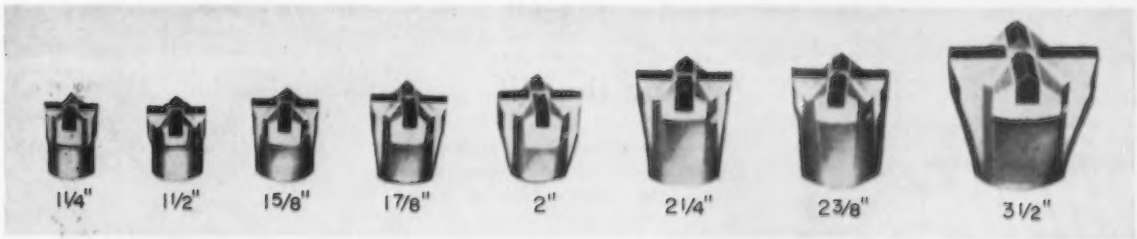
In the section on open-pit and underground types of rock bits, it should be noted that there is no clear-cut distinction in application of some of the bits shown. Small size bits are used in both open-pit and underground mines. Mining companies are now thinking of applying large-diameter bits of the pit to underground operations.



Rotary-Percussive Bits

COMBINATION of the impact of percussive drills and the boring action of rotary drills has improved penetration rates within certain ranges of applied thrust as shown in pioneering test report at right. This has required some modification in conventional bit design as shown in rotary-percussive drill bits above. Note emphasis on buttress backing given to tungsten-carbide inserts. Wallram bits.

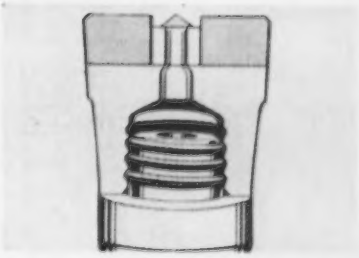




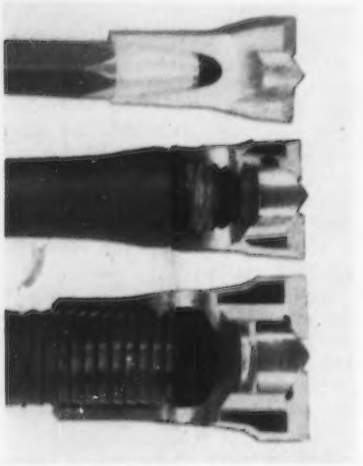
A Series of Bits

THE ABOVE SERIES of bits shows how a certain design can be made to fit a wide range of applications where size of hole and drilling conditions vary. This threaded, tungsten-carbide series has a shoulder-drive connection and side and center water holes. A similar series is available with bottom-drive threaded attachment. Intermediate bit sizes have been omitted.

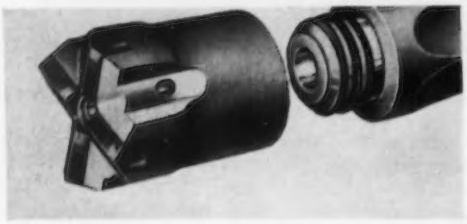
Sizes 1¼- to 1⅝-in. are good for jackhammers, feed-leg drills, medium stopers and light drifters. Sizes 1½- to 2-in. good for nearly everything except heavy-duty wagon drills and very small drills. Sizes 1⅞- to 2⅜-in. have proven useful on wagon-drills and for other purposes. Sizes 2¼- to 3½-in. have unusually strong attachments and are designed for hard rock or heavy duty wagon drills. Series "100" courtesy Ingersoll-Rand Co.



ABOVE SERIES has this shoulder drive.



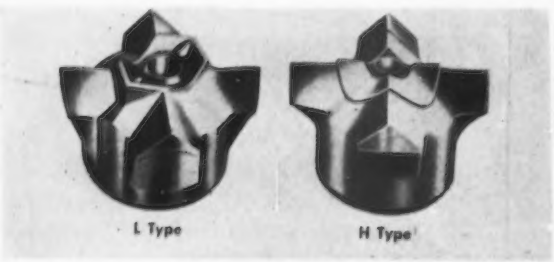
BOTTOM DRIVE is shown below, shoulder drive in middle and taper socket at top. All bits are cross-type.

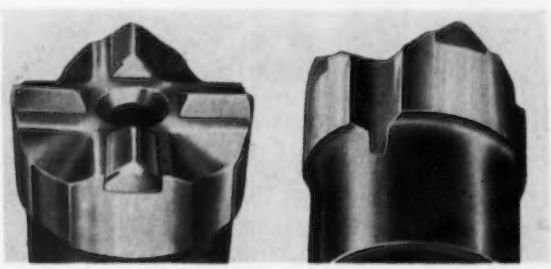


Emphasis Is on Drive

HAMMER BLOWS of bits have to be transmitted through the attachment. That is why manufacturers are now offering an increasing number of drive-types and a wide variety of thread or attachment designs to go with various series of bits. The combination of bit types with thread and attachment design practically gives you "custom-built" features for any kind of a drilling problem. At left we see three important attachment types for steel multiple-use rock bits.

Illustration top left shows a tungsten-carbide bit for shoulder-drive steel. Two new series: J20, 2¾- to 4-in.; and J60, 2½- to 3½-in., with bottom drive (see illustration top right) have been introduced recently for heavy-duty self-propelled rigs. Illustrations courtesy Joy Mfg. Co.

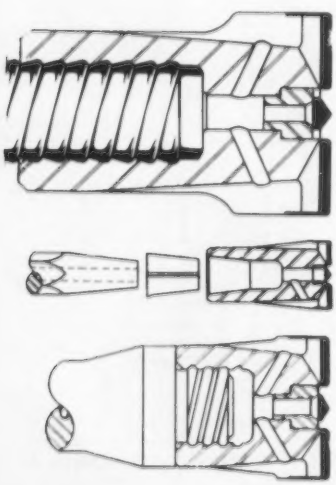




Drill-to-Destruction Steel and T-C Bits

A NEW-TYPE tungsten-carbide slip-on bit has been introduced recently to eliminate the cost of resharpening which may run as high as $1.75 per regrind according to the manufacturer. This type, shown at right can be used on round, hex or quarter-octagon steel.

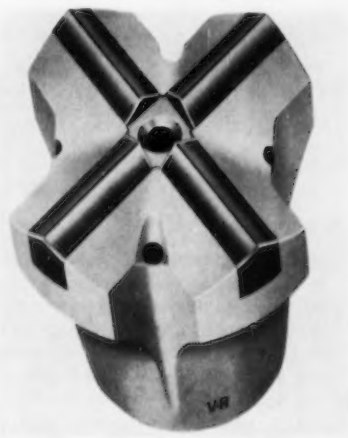
The L-type, Liddicoat, slip-on, pilot-design steel bit at left has two V-shaped wings that chip away a center hole and provide faster collaring and drilling. For highly abrasive rock the H-type is recommended because the wings are undercut with a reinforced radius to provide added strength. This type is effective where dulling in abrasive rock is less than gage wear. Illustrations courtesy Western Rock Bit Mfg. Co.



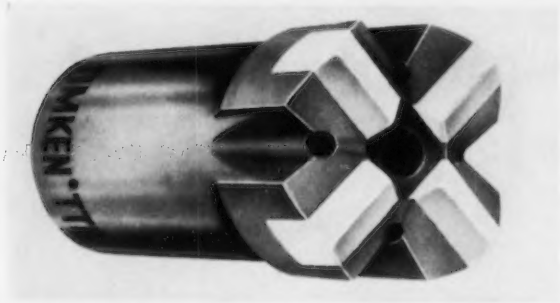
Seating the Bit

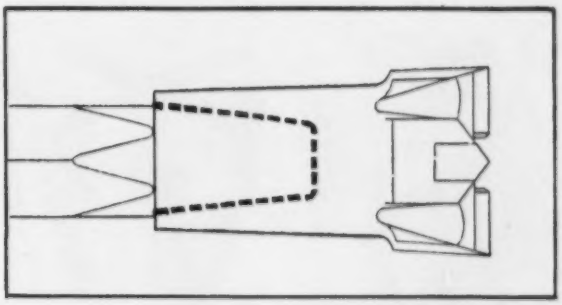
THREE DRIVE DESIGNS are shown at left. The bottom drive shown at top carries the impact load at bottom of the socket where the bit body is strongest. In the socket drive, center, a shim provides a snug fit between socket and tapered end of rod. In the shoulder drive, note ample clearance between end of rod and bottom of socket. This assures a tight seat on the shoulder and minimum load on the threads. Bottom drive bits come in sizes of 1⁹⁄₁₆- to 5-in.; push-on or socket bits, 1¼- to 5-in. Shoulder types range from 1⅜- to 4-in.

X-type bit shown at right has been introduced recently to eliminate rifling and provide uniform holes in hard ground. Vascoloy-Ramet Corp.



X-TYPE BIT prevents rifling and provides uniformly round holes in hard ground.



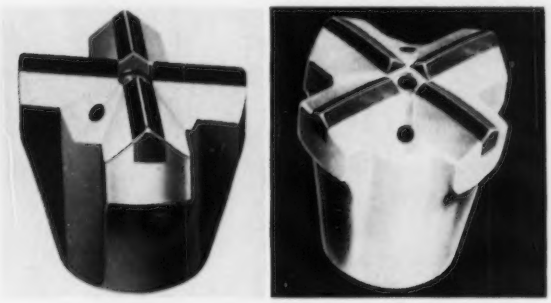


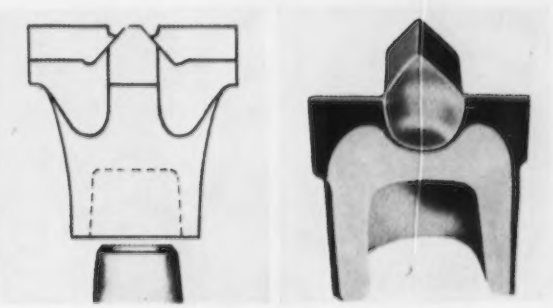
Tapered Socket for Air-Leg Rock Drills

INTRODUCTION of air-leg drills has required redesign of bits to increase speed and reduce cost per foot. This newly introduced tapered-socket bit is given a snug fit to the steel through a precision-made taper. Despite this firm fit, the bit can be removed from a steel easily, and a new sharpened tungsten-carbide bit readily attached to the same steel.

Bit designers are also placing greater emphasis on removal of rock cuttings.

Note, for instance, five-hole cutting removal advantages incorporated in the series of threaded detachable bits shown at right. Undercuts under the heel are deeper to speed cutting removal. These T-C bits are interchangeable with steel bits. Timken.



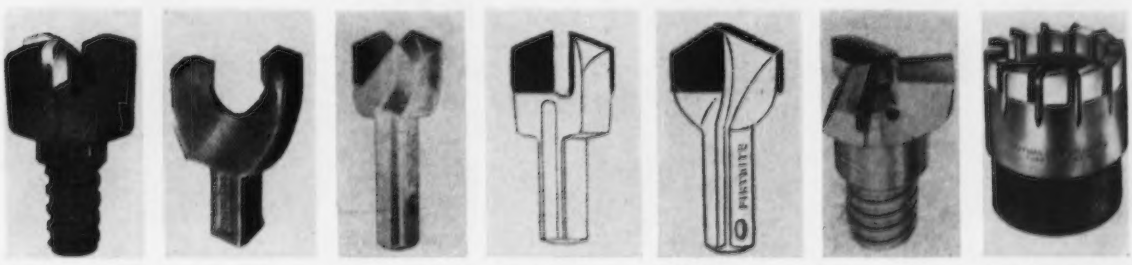


X-Type Prevents Rifling

Two new X-bits available in 3½-, 4- and 4½-in. gage sizes are made to fit directly on 1½- and 2-in. drill rods without a special adapter. Bits shown above have a center hole and two additional face holes. Another type of X-bit made by this company has a center hole, two face holes and two side holes—five in all. The purpose of the X-design and the ample flow of water to the face of the bit is to clear the hole of cuttings as soon as possible. Illustrations, courtesy Brunner & Lay Rok-Bit.

Slip-On Bit Holds Fast

One-Use bit is held on by slight difference in taper of bit socket and the button-end of the rod. Cross-section at right shows uniform hardened depth. Even though cohesive strength of bit on rod is several tons, bit can be dislodged with a sharp blow. Other features stressed in this design are the stronger wings, offset gage which reduces area of the reaming face exposed to rubbing action against the rock, and a steeper reaming angle which eliminates excessive binding. Illustrations courtesy LeRoi-Cleveland.



1. Vascoloy-Ramet *2. Allegheny Ludlum* *3. Kennametal* *4. Carboloy* *5. Firth Sterling* *6. Kennametal* *7. Hoffman Bros.*

Rotary Bits. 1. Three-prong type. 2. Two-prong, wide-slot for soft rock, passes chips easily. **3. Roof-type** with small V-slot for medium hard ground. **4. Groove in shank** is for cooling wash or wetting water. **5. Solid insert** is best in variable or harder rock. **6. Drag bit** has wide inserts for long wear. **7. Rotary coring type.**

TUNGSTEN-CARBIDE Tricone bit for I-R Roto-Master and Quarrymaster drills.

SIX-INCH tungsten-carbide bit for I-R down-the-hole drilling rig.

TUNGSTEN-CARBIDE 4¼ in. bit for I-R Powermaster drilling rig.

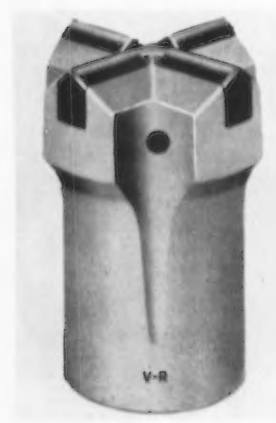
FOUR-POINT tungsten-carbide bit, 5¼ to 6¼ in., for I-R Quarrymaster drilling rig.

X-TYPE 5-in. T-C bit has five water holes. This design eliminates rifling. Kennametal.

X-DESIGN of this T-C bit prevents squaring of hole. Size 4½-in. Joy Mfg. Co.

NEW 6-in. T-C percussion bit for Quarrymaster drills. Rok-Master bit, Brunner & Lay.

SPLINED T-C 6-in. percussion bit for down-the-hole drills. Bruner & Lay.



LONG-BODY 5-in. cross-style T-C bit. Vascoloy-Ramet.

OVERHANG T-C bit for soft abrasive rock, Vascoloy-Ramet

FINGER BIT for broken shales and limestone, Varel.

CEMENTED CARBIDE rotory for hard rock. Varel, CC.

THREE-CUTTER rotary bit with regular circulation directed at teeth. H. C. Smith.

THREE-CUTTER jet type is fitted with tungsten-carbide nozzles. H. C. Smith Co.

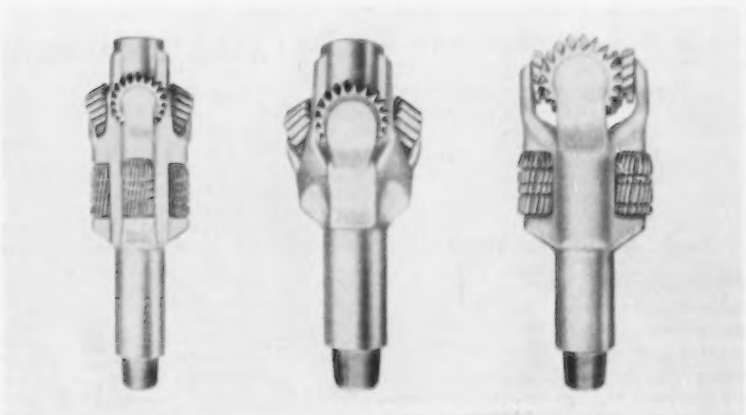
TRICONE BIT type OSC for drilling soft to medium formations. Hughes Tool Co.

TRICONE BIT type RG-2J for drilling extremely hard formations. Hughes Tool Co.

THREE-WING prop-type auger is fitted with tungsten-carbide bits. Size 4⅝ to 8⅝-in. Austin Powder.

AIR-BLAST rotary bit uses compressed air to clean and cool cutting teeth. Varel Mfg. Co.

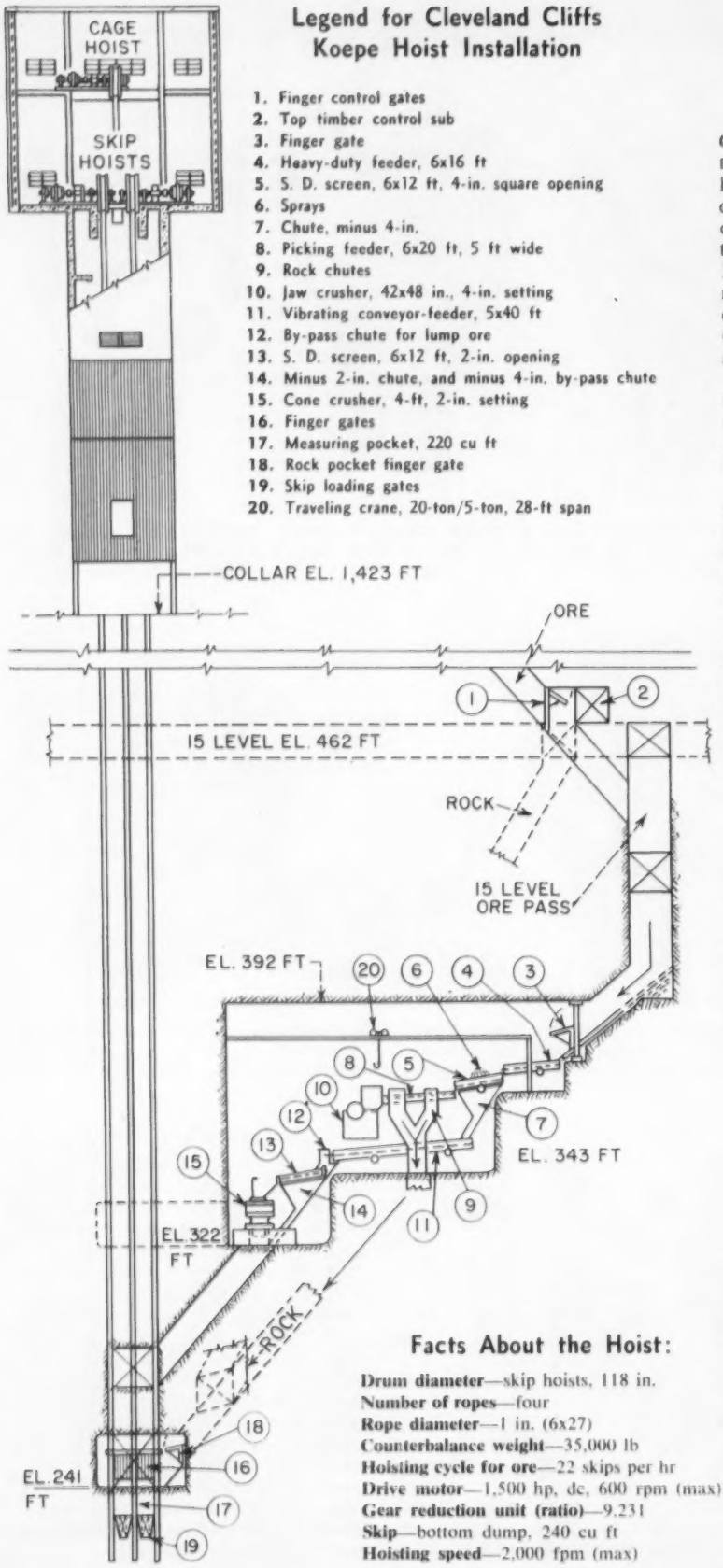
THREE-CONE blast-hole drill for open-pit mining features replaceable cones and better protection for bearings from cuttings. Central Mine Equipment Co.



SIX-POINT reamer with three bit gage cutters and three reamers (left); three-point hole opener (center); four-point reamer rock bit. H. C. Smith Oil Tool Co.

For a Complete Review

Consult the 1956 Mid-June Mining Guidebook to supplement up-to-date technical and equipment sections presented in this guidebook. See complete line of diamond-drill bit types in 1956 Guidebook sections on exploration and mining, also jumbos, large open-pit rock drills and underground drill designs. Foregoing items highlight progress in various types of mine equipment. See Buyers' Guide section of this issue for complete classification of equipment and supplies used in the mining industry, consult advertisements in this issue, and write to manufacturers in directory section for more complete information. Local manufacturers' sales offices are included in this issue for first time.



Legend for Cleveland Cliffs Koepe Hoist Installation

1. Finger control gates
2. Top timber control sub
3. Finger gate
4. Heavy-duty feeder, 6x16 ft
5. S. D. screen, 6x12 ft, 4-in. square opening
6. Sprays
7. Chute, minus 4-in.
8. Picking feeder, 6x20 ft, 5 ft wide
9. Rock chutes
10. Jaw crusher, 42x48 in., 4-in. setting
11. Vibrating conveyor-feeder, 5x40 ft
12. By-pass chute for lump ore
13. S. D. screen, 6x12 ft, 2-in. opening
14. Minus 2-in. chute, and minus 4-in. by-pass chute
15. Cone crusher, 4-ft, 2-in. setting
16. Finger gates
17. Measuring pocket, 220 cu ft
18. Rock pocket finger gate
19. Skip loading gates
20. Traveling crane, 20-ton/5-ton, 28-ft span

Facts About the Hoist:

Drum diameter—skip hoists, 118 in.
Number of ropes—four
Rope diameter—1 in. (6x27)
Counterbalance weight—35,000 lb
Hoisting cycle for ore—22 skips per hr
Drive motor—1,500 hp, dc, 600 rpm (max)
Gear reduction unit (ratio)—9.231
Skip—bottom dump, 240 cu ft
Hoisting speed—2,000 fpm (max)

Trends in

First U. S. Koepe Unit

CLEVELAND-CLIFFS IRON CO. installed the first multiple rope Koepe-type hoist on the North American continent. Details of the two skip hoists and cage hoist installed at the C shaft of the Cliffs Shaft Mine at Ishpeming, Mich., are shown at left. After ten months of operation, E. D. Cory, chief electrical engineer for Cleveland Cliffs, reported the following operating results:[1]

1. As many as 4,200 tons of ore have been hoisted during a single shift. During the 10-month period more than 500,000 tons of ore were hoisted.

2. Unlubricated hoist ropes appeared to be perfect except for some mild scrubbing that occurred at their contacts with deflection sheaves during initial adjustment of brake application controls.

3. Maximum friction liner wear at the end of the 10-month period was 5/32-in. indicating that liners would last five years or more under present operating conditions.

4. Rope equalization has presented no problems. Slight adjustments at three-month intervals appear to be ample.

5. Air-powered brakes have operated smoothly and positively.

6. Electrical controls "have functioned exceptionally well and, in spite of the complexities introduced by remote push-button control, have caused no more operational trouble than we have experienced with other hoists which are operated by hoist operators at manual controllers in the hoist room."

ASEA Friction-Drive

Company	Country
Cleveland-Cliffs Iron Co., Mich.	U. S.
Cleveland-Cliffs Iron Co., Mich.	U. S.
Falconbridge Nickel Mines Ltd., Ont.	Canada
Falconbridge Nickel Mines Ltd., Ont.	Canada
Algoma Ore Properties Ltd.	Canada
National Potash Co., N. M.	U. S.
National Potash Co., N. M.	U. S.
Madsen Red Lake Gold Mines Ltd.	Canada
Madsen Red Lake Gold Mines Ltd.	Canada
Falconbridge Nickel Mines Ltd., Ont.	Canada
Caland Ore Ltd.	Canada
Caland Ore Ltd.	Canada

[1] "Koepe Hoist Installations at Cliffs Shaft Mine," by E. D. Cory, *Mining Congress Journal*, January 1957.

Modern Mine Hoisting

WITHOUT QUESTION mine hoisting systems are now approaching a long awaited par with industrial elevator installations. Multiple rope suspension, push-button controls, smooth cage and skip travel and improved safety devices are but a few of the available features which these two systems have in common. Electrical controls incorporating rototrols, amplidynes or similar units now eliminate motor burn-outs, peak loads and shocks to the entire mechanical and electrical system which hand operation and primative electrical designs imparted to hoisting.

Forward-looking mine planners now believe that many of the long climbs up stope and raise ladders will be eliminated through the installation of easily transportable and extendable man hoisting systems. Borehole access ways with circular man-cages are in use in coal mines, and there is no reason why similar units cannot be applied to metal and non-metallic mines. The drilling of large-diameter underground boreholes is now entirely feasible. All that is needed is a fresh approach to the planning of development workings so that man transportation is as effectively provided as that of ore, waste and materials handling.

Multiple-rope, friction-drive push-button hoisting is high on the list of modern developments which are attracting interest. Although the application of friction-drive hoisting (Koepe system) is about 75 years old in Europe, and in the U. S. the Shenandoah-Dives property at Silverton has used a friction-drive hoist for years in its upper levels, certain modern improvements have directed a surge of interest in this system of hoisting. These are the use of multiple ropes, smaller drum diameters, higher motor speeds, higher drum speeds, lower motor-to-drum speed ratios, reduced starting inertia of hoist parts and improved control systems permitting push-button operation.

The illustration and legend at left illustrate the first Koepe type hoist to be installed in the U. S. The table at the bottom of the page gives essential details about 14 hoists delivered or to be installed in the U. S. and Canada.

Push-button controls and automatic or semi-automatic hoisting are not peculiar to friction-drive units nor are they new. Automatic hoisting has been used for many years at the Inspiration property in Arizona, and Johns-Manville has been operating its hoists at Asbestos, Quebec, with push-button controls for years. See E&MJ April 1948. Two large push-button hoists are installed at Sudbury, Ontario, and at San Manuel, Ariz., (see next page) semi-automatic controls enable the skip tender to start the hoisting cycle by push-button from the skip loading station underground without the aid of a hoistman.

Another pronounced hoisting trend is the adoption of bottom dump skips in preference to Kimberley-type skips. Objections to Kimberley type skips are: (1) Design of dumping irons at the headframe is complicated, (2) Overturning of skips places shock loads on the rope and hoisting system and (3) Unloading of skips at headframe takes longer than loading of skips at pocket. This is decidedly unfavorable in systems requiring smooth and rapid hoisting cycles. Anaconda has pioneered in this field at Butte with excellent speed benefits. Johns-Manville has converted from Kimberley-type skips at Asbestos, Quebec, to bottom-dump skips. San Manuel selected bottom-dump skips for its high-tonnage hoisting system in Arizona. For a panorama of bottom-dump skip designs, see *E&MJ* Mining Guidebook issue, Mid-June 1956, pp 100 and 101. Structural materials used to construct skips and cages to save weight and combat corrosion include alloys, aluminum and stainless steel.

Headframe designs also have undergone an evolution. Homestake eliminated idler towers and installed elevators for sheave inspection and lubrication some years ago. See following pages. Circular concrete head frames eliminated the need of support legs. Friction drive units installed on top of headframes do away with a separate hoist house entirely. In South Africa, headframes have been installed with support legs on opposite sides of the shaft to permit hoists to operate in opposed fashion (*E&MJ*, April 1957, p 116). At Kiruna, Sweden, surplus heat from electrical equipment in the hoist house and ore-dressing plant is the sole source of heat for these buildings. Winter temperatures drop as low as 20 to 40 deg below zero (*E&MJ*, April 1957, p 116).

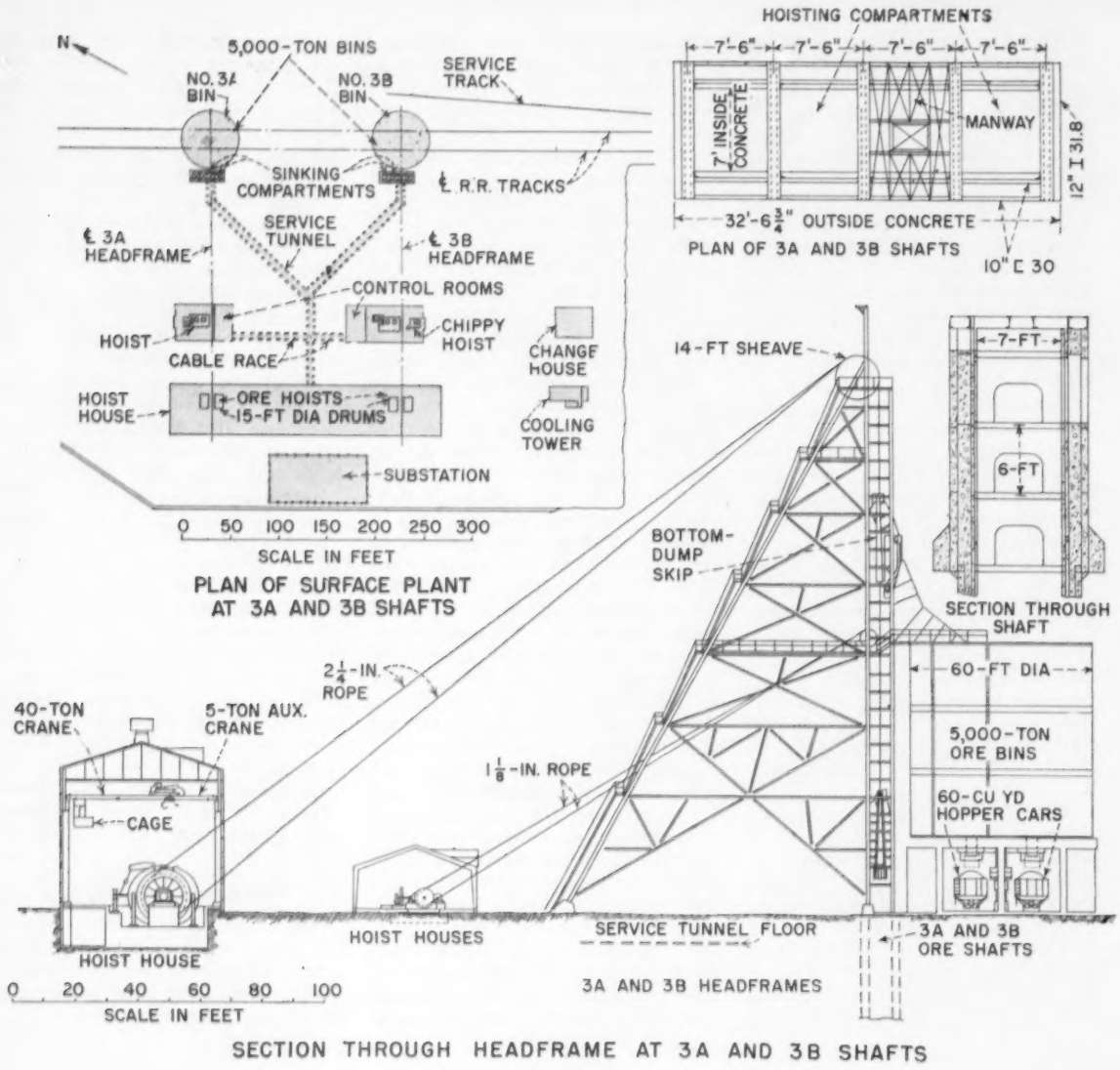
Three Modern Types

Three types of hoists are shown in this section of the Guidebook to illustrate modern design—a friction-drive unit, a double-drum hoist and a cylindro-conical installation.

Hoists Delivered or Under Manufacture for Mines in the U. S. and Canada

Year of delivery	Name of shaft	Number of hoists	Type of hoist	Pulley dia (in.)	Ropes Number	Ropes Dia (in.)	Winding distance (max) (ft)	Hoisting speed (max.) (fpm)	Load (lb)	Weight Skip (lb)	Weight Cage (lb)	Balance weight (lb)	Horsepower	Winding motor (rpm)	Winding motor (volts)	Manner of operation
1954	"C" Shaft	1	1 cage	89	4	1	3,940	2,000	15,000	....	13,000	20,500	1,500	600	525	PB 12
1954	"C" Shaft	2	1 skip	118	4	1⅛	3,940	2,000	30,000	20,000	....	35,000	1,500	600	525	PB 6
1955	No. 1 Fecunis	1	2 skips	118	4	1¼	4,200	2,240	17,000	19,000	....	....	1,500	600	600	PB 2
1955	No. 1 Fecunis	1	1 cage 1 skip	118	4	1⅛	4,200	2,040	13,000	....	16,000	22,500	665	750	600	PB 15
1955	Helen Shaft	1	1 cage	89	4	1	4,000	1,500	13,500	12,000	12,000	....	800	750	600	PB 12
1956	Carlsbad	1	1 cage	69½	4	¾	1,740	800	15,000	....	6,500	13,000	245	750	440	PB 2
1956	Carlsbad	1	2 skips	88	4	1	1,895	1,260	20,000	24,000[1]	....	....	950	750	600	PB 2
1957	Austin	1	2 skips	132	4	1¼	5,200	1,500	18,000	20,000	....	....	1,100[2]	750	440	PB 3
1957	Austin	1	1 cage	132	4	1⅛	5,200	1,500	14,000	....	14,500	21,500	550	750	440	PB 24
1957	No. 9	1	1 skip	108	4	1⅛	4,350	2,000	17,000	17,000	....	25,500	2,500	750	440	PB 4
1958	Falls Point	2	1 skip	120	4	1⅜	2,125	1,850	33,000	22,000	....	38,000	1,350	720	600	PB 3
1958	Falls Point	1	1 cage	110	4	1¼	2,125	1,500	18,000	....	19,500	28,000	600	750	440	PB 4

Manner of operation, PBx = push-button operation from x levels; Hoisting speed, when two dates are given, the last one refers to the first extension for which given motor is dimensioned. [1]Including additional load of 12,600 lb. [2]Two motors. All electrical systems for installations above have Ward-Leonard units, and hoist motors are all dc.



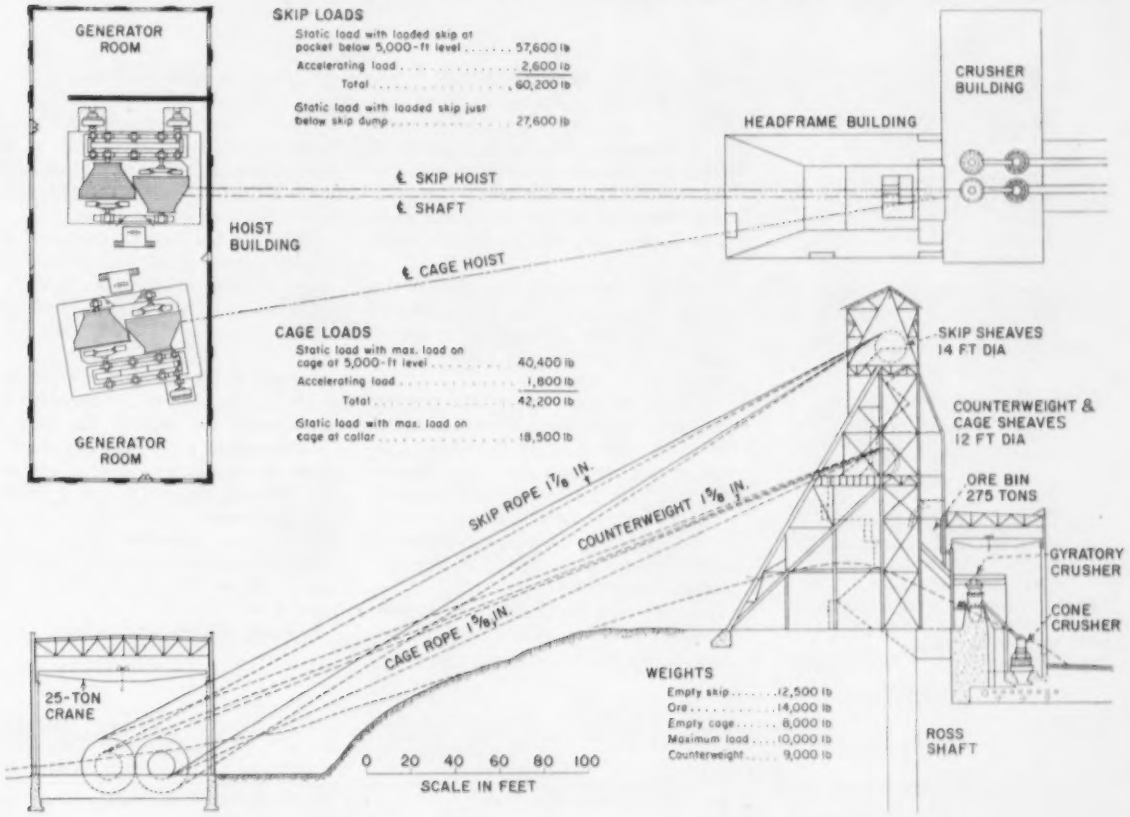
San Manuel's Powerful Drum Hoisting System

SAN MANUEL's new twin hoisting system in Arizona is designed to hoist 35,000 tpd ore from the present 1475-ft level and from future lower levels at a maximum speed of 3,000 fpm. The 3A and 3B hoists are cylindrical double-drum units geared to twin 3,000-hp, 600-v dc motors. Drums have a 116-in. face and a 15-ft diameter, and will wind 1800 ft of 2¼-in. rope on one layer. Each hoist has its own motor-generator set with flywheel, set for 80% power peak utilization. These units consist of a 4,000-hp, 2300-v induction motor driving two 2500-kw dc generators.

Ore is hoisted from shaft loading stations in 18-ton bottom-dump skips traveling on steel guides. Ore loaded into skips is measured in steel baskets controlled by under-cut guillotine-type gates. Ropes are 2¼-in. preformed. Skips do not run in adjacent compartments, but are separated by a manway. This was done to provide the proper fleet angle.

Bottom-dump skips discharge into 60-ft dia, 5,000-ton capacity steel ore bins at the headframe which load directly into the standard-gage, 100-ton, hopper-bottom ore cars provided to ship ore from the mine to the mill at San Manuel 8 miles east of the headframes.

Shaft width is 7 ft inside concrete, and length is 32 ft 6¾ in. over-all. Steel sets were installed on 6-ft centers. See *E&MJ*, April 1956, for full details of the San Manuel project.


GENERATOR ROOM
SKIP LOADS
Static load with loaded skip at pocket below 5,000-ft level ..... 57,600 lb
Accelerating load ..... 2,600 lb
Total ..... 60,200 lb
Static load with loaded skip just below skip dump ..... 27,600 lb
HEADFRAME BUILDING
CRUSHER BUILDING
℄ SKIP HOIST
℄ SHAFT
HOIST BUILDING
℄ CAGE HOIST
CAGE LOADS
Static load with max. load on cage at 5,000-ft level ..... 40,400 lb
Accelerating load ..... 1,800 lb
Total ..... 42,200 lb
Static load with max. load on cage at collar ..... 18,500 lb
GENERATOR ROOM
SKIP SHEAVES 14 FT DIA
COUNTERWEIGHT & CAGE SHEAVES 12 FT DIA
ORE BIN 275 TONS
GYRATORY CRUSHER
CONE CRUSHER
SKIP ROPE 1⅞ IN.
COUNTERWEIGHT 1⅝ IN.
CAGE ROPE 1⅝ IN.
25-TON CRANE
WEIGHTS
Empty skip ..... 12,500 lb
Ore ..... 14,000 lb
Empty cage ..... 8,000 lb
Maximum load ..... 10,000 lb
Counterweight ..... 9,000 lb
ROSS SHAFT
0 20 40 60 80 100
SCALE IN FEET

Why Homestake Selected the Cylindro-Conical Hoist

DESIGN OF THE HOIST was developed by engineers of Nordberg Manufacturing Co. to meet the following conditions specified by the Homestake engineering and operating staff:

1. Drums should be large enough to wind the ropes in one layer. Ultimate length of rope was stipulated. This was done to reduce rope wear.

2. Hoists were to be placed as near to the shaft as possible to eliminate idler towers and rope whip which also contribute to rope wear.

3. Duplicate parts should be used where possible to simplify inventories of spare parts. This was attained particularly well in the electrical equipment installed.

4. Power peaks were to be kept at a minimum.

HOIST DATA

Drum diameter: 25 ft on large end, and 12 ft on smaller end.

No. of ropes: One for each drum, single wrap.

Rope diameter: All ropes are 1⅞-in. except for Ross man hoist which is 1⅝ in.

Counterbalance weight: On Ross man hoist only, 11,000 lb.

Drive motors: Yates ore hoist has two dc 1,500-hp, 350-rpm motors. Yates man hoist has same motors as ore hoist. Ross ore hoist has two dc 1,500-hp, 300-rpm motors. Ross man hoist has one dc 1,500-hp, 300-rpm motor.

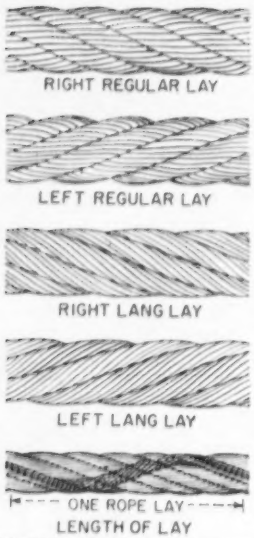
Gear reduction units: Yates ore hoist, 9.0; Yates man hoist, 8.9; Ross ore and man hoists, 8.56.

TANDEM cylindro-conical Nordberg hoist installed to handle ore at the Yates shaft.

Skips: Kimberley type. Yates shaft, 8-ton capacity; Ross shaft, 7½-ton capacity.

Hoisting speed: 3,078 fpm, maximum.
No. of hoisting levels: 5

Selecting the Right Wire Rope



The one rope lay indicated is lengthwise distance in which a strand makes one complete turn around the rope

Major points in rope selection.

1. Length. Manufacturer prefers that user specify length of wire rope.

2. Diameter. Determine diameter of rope by measuring circle which just touches extreme outer limits of strand.

3. Number of strands, number of wires per strand and kinds of fabrication.

4. Lay. The term "lay" is used to describe (1) the appearance or construction of the rope in regard to its spiral, and (2) to measure the length of the spiral of the rope.

Under the first "lay" is denoted the direction of rotation, or spiral or helix, of either the wires in the strands or the strands in the rope. As a consequence, it is necessary to distinguish between lay of strands and lay of wires in the strands by further qualifications involving the terms right lay, left lay, regular lay and lang lay.

In right lay the strands in a rope rotate clockwise, while in the left lay they rotate counterclockwise.

In a regular lay rope the wires in a strand rotate in a direction opposite to the rotation of the strands in the rope. Consequently, the outside wires in the finished rope are roughly parallel to the core of the rope.

In a lang lay rope the wires of the strands rotate in the same direction as the strands rotate in the rope.

The second "lay" relates to length, such as "length of lay" and "one rope lay."

Length of lay indicates the distance in which a strand makes one complete turn around the core of the rope. It is measured in a straight line parallel to the center line of the rope and not by following the strand as it spirals

5. Preformed. This process permanently forms each individual strand, and the wires composing it, into the helical shape it will assume in the finished wire rope.

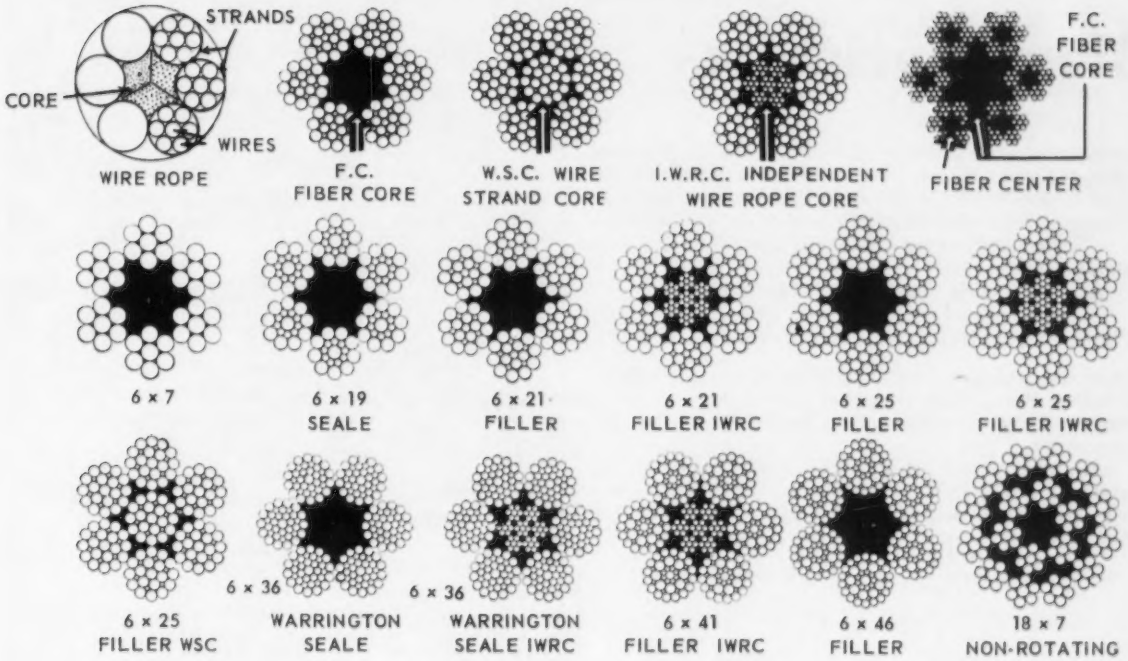
6. Kind of core. See below.

Wire Rope

FC—Fiber core; CC—Cotton core; AC—Asbestos core

Use	Size (in.)	Construction	Lay	Core
Vertical shafts	1/2 to 1 1/8	6 x 19 Filler wire	regular or lang	FC
	3/4 to 2 1/4	6 x 21 "	regular or lang	FC
	3/4 to 2 1/4	6 x 25 "	regular or lang	FC
	3/4 to 2 1/4	6 x 27 Flattened strand	lang	FC
	3/4 to 2 1/4	6 x 30 "	lang	FC
	1/2 to 1 1/2	18 x 7 Non-rotating	regular l & r	FC
Inclined shafts	5/8 to 1 1/2	6 x 19 Seale	reg. or lang	FC
	1 to 2	6 x 21 Filler wire	reg. or lang	FC
	3/4 to 2 1/4	6 x 25 Flattened strand	lang	FC
	3/4 to 2 1/4	6 x 27 "	lang	FC
Mining machines (cutters, etc.)	1/2 to 3/4	6 x 25 Filler wire	regular	IWRC
	1/2 to 9/16	6 x 29 "	regular	IWRC
	5/8 to 3/4	6 x 36 "	regular	IWRC
	5/8 to 7/8	6 x 41 Warrington-Seale	regular	IWRC
Slushers and scrapers	5/8 to 1	3 x 19 Seale	regular	—
	3/16 to 1 1/4	6 x 19 Seale	regular	FC
Tugger hoists	1/4 to 9/16	6 x 19 Seale	regular	FC
	5/8 to 3/4	6 x 21 Filler wire	regular	FC
Aerial tramways				
Track strands	1/2 to 1 3/8	Smooth coil track strand 25 to 147 wires	—	—
	3/4 to 3	Full-locked coil strand	—	—
	3/4 to 3	Half-locked coil strand	—	—
Traction wire ropes	1/2 to 3/4	6 x 7 Traction	regular	FC
	3/4 to 1 1/4	6 x 19 Seale	regular	FC
Power shovels				
Hoist lines	1/2 to 1 1/8	6 x 19 Filler wire	lang	IWRC
	1/2 to 1 1/4	6 x 25 "	lang	IWRC
Boom lines	1/2 to 1 1/8	6 x 19 Filler wire	regular	FC or IWRC
	1/2 to 1 1/8	6 x 25 "	regular	FC or IWRC
Crowd lines	1/2 to 1 1/8	6 x 25 Filler wire	lang	IWRC
	1/4 to 3 1/2	6 x 37 Class	reg. or lang	IWRC or FC
Trip or dump lines	1/4 to 1 1/16	8 x 19 Warrington	regular	FC
	1/2 to 1 1/4	6 x 25 Filler wire	regular	FC

Typical Cross-Sections of Wire Rope and Strand



Courtesy of MacWhyte Co.

Applications

IWRC—Independent wire rope core; WSC—Wire strand core

Use	Size (in.)	Construction	Lay	Core
Churn drills				
Drilling lines	5/8 to 1	6 x 16 Filler wire	left lay	FC
	5/8 to 3/4	6 x 21 "	left lay	FC
Sand line	1/4 to 5/8	6 x 7 Plow steel	right lay	FC
Draglines				
Hoist lines	5/8 to 1	6 x 16 Filler wire	lang	WSC
	1/2 to 1 1/4	6 x 25 "	lang	IWRC
Boom lines	1/4 to 2 3/4	6 x 19 Filler wire	regular	FC or IWRC
	1/4 to 2 3/4	6 x 25 "	regular	FC or IWRC
Drag ropes	1/4 to 3/4	6 x 19 Seale	lang	IWRC
	7/8 to 1 5/8	6 x 21 Filler wire	lang	IWRC
	1 1/4 to 2	6 x 25 "	lang	WSC
Wheeled scrapers	1/2	6 x 21 Seale	lang	IWRC
	9/16	6 x 25 Filler wire	lang	IWRC
Bulldozers		As above		
Bucket ladder dredges				
Ladder hoist lines	3/4 to 1 3/4	6 x 21 Filler wire	lang	WSC
Bow lines or swing lines	5/8 to 1 1/8	6 x 21 Filler wire	lang	WSC
	1 1/4 to 1 1/2	6 x 25 "	lang	WSC
	1 to 1 1/2	6 x 19 Seale	regular	IWRC
Overhead cranes	3/8 to 1/2	6 x 36 Filler wire	regular	FC
	9/16 to 1 1/8	6 x 38 "	regular	FC
Drag scrapers				
Digging line	1/4 to 5/8	6 x 19 Seale	regular	WSC
	3/4 to 1 1/8	6 x 21 Filler wire	lang	WSC
	1 1/4 to 2	6 x 25 "	lang	WSC
Haulback line		As above		
Slackline cableway excavator				
Track line	1 1/4 to 2	6 x 25 Filler wire	lang	WSC or IWRC
Digging line	1/4 to 5/8	6 x 19 Seale	regular	WSC
	3/4 to 1 1/8	6 x 21 Filler wire	lang	WSC
	1 1/4 to 2	6 x 25 Filler wire	lang	WSC
Tension line	1/2 to 1	6 x 25 Filler wire	regular	WSC

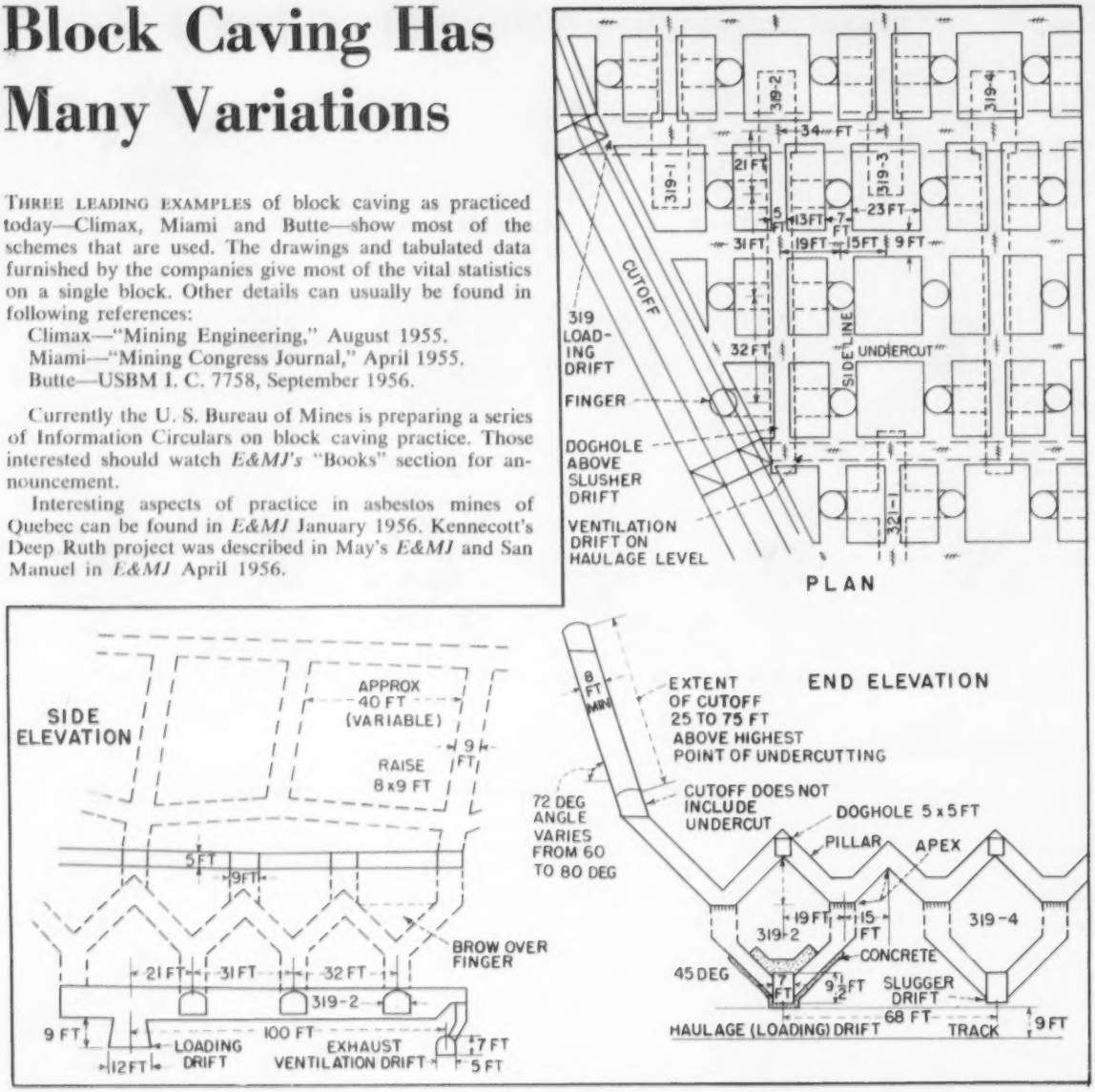
Block Caving Has Many Variations

THREE LEADING EXAMPLES of block caving as practiced today—Climax, Miami and Butte—show most of the schemes that are used. The drawings and tabulated data furnished by the companies give most of the vital statistics on a single block. Other details can usually be found in following references:

Climax—"Mining Engineering," August 1955.
Miami—"Mining Congress Journal," April 1955.
Butte—USBM I. C. 7758, September 1956.

Currently the U. S. Bureau of Mines is preparing a series of Information Circulars on block caving practice. Those interested should watch *E&MJ's* "Books" section for announcement.

Interesting aspects of practice in asbestos mines of Quebec can be found in *E&MJ* January 1956. Kennecott's Deep Ruth project was described in May's *E&MJ* and San Manuel in *E&MJ* April 1956.



TYPICAL LAYOUT along hanging wall on Storke level is example of direct draw into slusher drift, drawpoints opposite each other, single-end slusher drifts and direct slusher loading of cars. Scrams are fully lined with unreinforced 18-in. thick concrete which gives better service than if reinforced with steel. Ribs and floor of scram at tail block are angled to prevent damage to block. Cutoff reduces arching thus helping to speed caving in new areas.

Climax Scrapes Below Unusual Undercut

Climax Mine, Climax Molybdenum Co., Climax, Colorado.

GEOLOGY:

Ore occurs in 250- to 400-ft thick zone around domed core of highly silicious rock in pre-Cambrian granites, schists and Climax porphyry. Faults limit mining on northeast and northwest and shear zone makes mining costly to southwest. Mineralization, believed early Tertiary, is fracture filling of molybdenite-quartz vienlets mostly under ½-in. wide. Economically, primary mineral is molybdenite and secondary minerals are hubernite, pyrite and cassiterite. Minimum grade limit of 0.4% MoS_2 establishes mining boundaries.

Height of ore caved: 125 to 475 ft (approximate average: 300 ft).

Thickness of capping: 0 to 1,250 ft.

Single caving unit, horizontal dimensions: stope 68x100 ft. Caving is not by blocks but by continuously advancing cave from hangingwall to footwall, progressively around circular core.

SEQUENCE OF OPERATIONS in bringing unit into production:

Drive haulage and ventilation drifts.

Cutout for slusher hoists and platforms.
Concrete cutouts and haulage drifts.
Drive slusher drifts and ventilation connections.
Concrete slusher drifts.
Drive finger raises and undercuts which form pillars in stopes.
Longhole pillars and blast by retreat method.
Smallest area required to start caving action: 200x400 ft.

BOUNDARY CUTOFF SCHEME:

Total cutoff on footwall by raises-and-pillars or shrinkage stopes. Hangingwall cutoff by raises-and-pillars to minimum height of 50 ft.

GROUND SUPPORT:

In haulageway: 12x12-in. timber or concrete.
In slusher drifts: concrete 18 in thick. Use roof bolts with wire mesh prior to concreting if necessary.
In undercut: timber stulls.
In raises: timber sets.

ORE GATHERING:

Draw control: uniform draw to maintain a 10% differential in height of ore column between rows of draw points going away from solid ore. If increase in production is required, differential may go to 15% on draw points over 50% drawn.

Draw angle: about 45 deg, probably less than 45 deg at start and greater than 45 deg toward exhaustion of stope.

Area per drawpoint: 1133½ sq ft (11⅓ x 34 ft).

Drawpoint discharge opening: width—8 ft, height—4½ ft (top arched to cut wear).

Slusher dump opening: 3⅔ x 6⅔ ft clear.

Slusher bucket: 72 in. wide by 56 in. high (24 in. when folded) folding, moves 3.2 tons per pass. Some 60-in. folding buckets too.

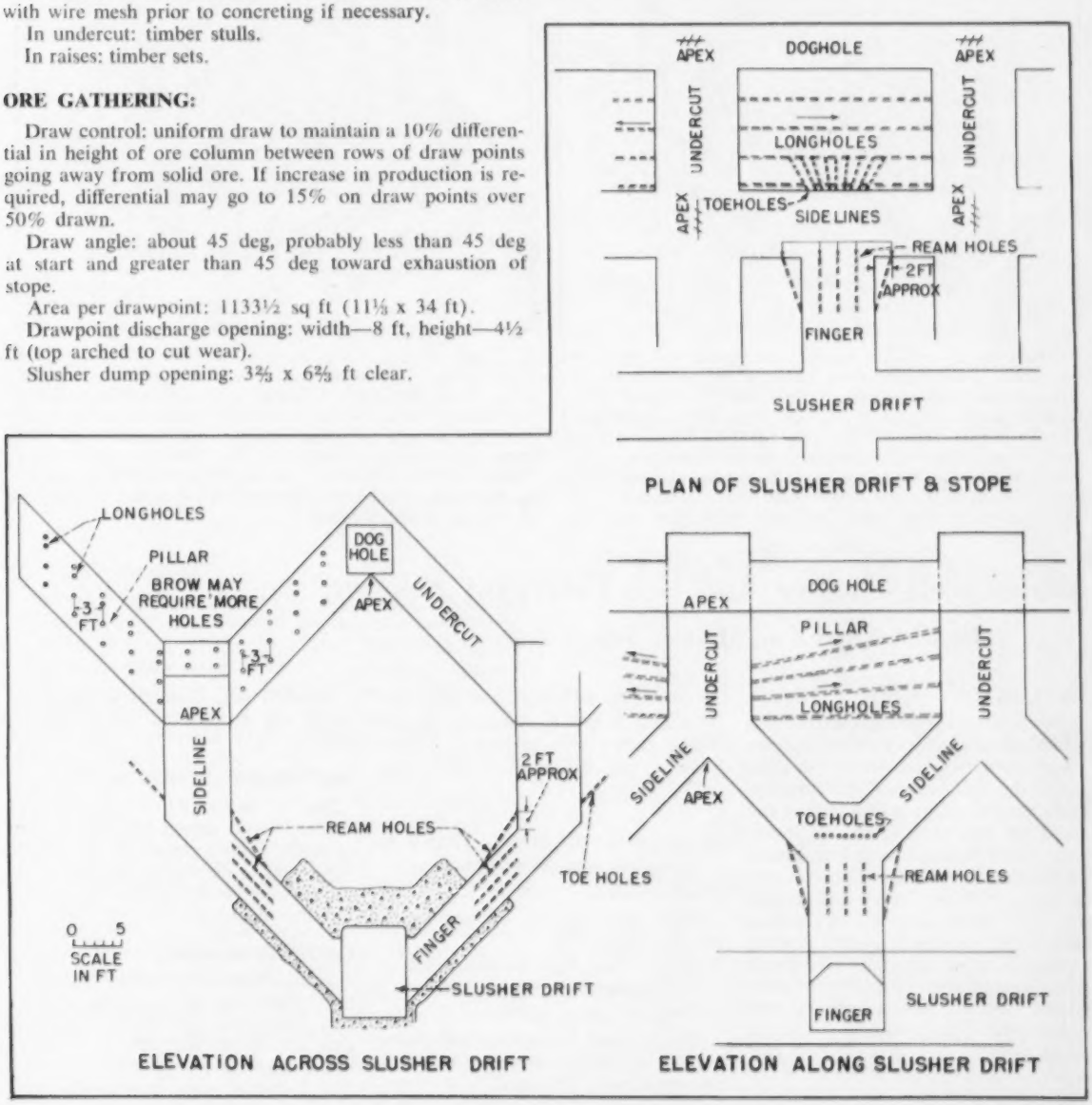
Slusher hoist: two drum tandem, 150 hp.

Car loading chute gate: none, direct loading by slusher.

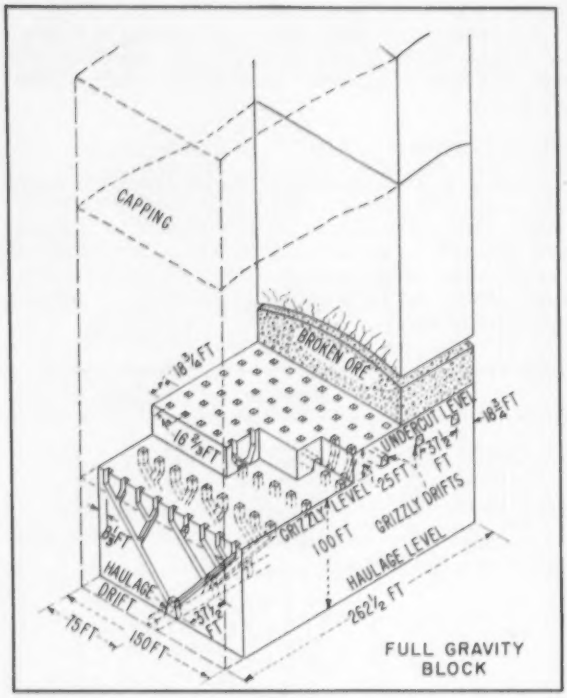
Haulage: 20- to 24-car trains, 180-cu ft (9-ton) Granby type cars with 30-ton trolley locomotives, 8-wheel, double truck.

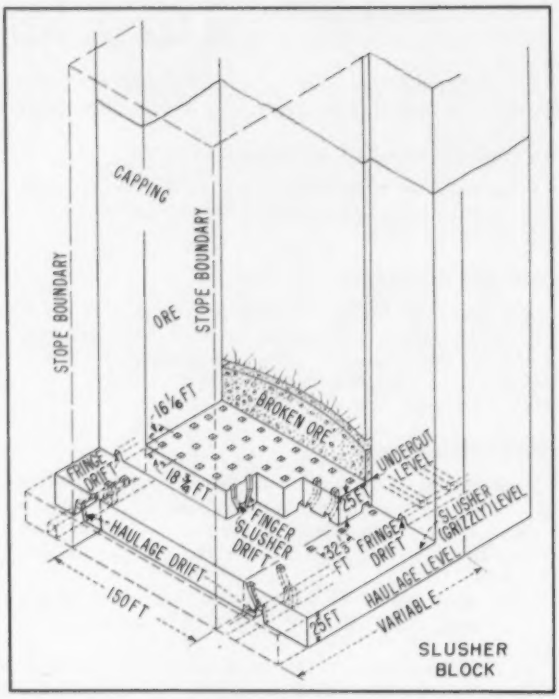
VENTILATION:

Clean air is under positive surface fan pressure in haulage drifts. It moves up through slusher dump hole into slusher drift. Contaminated air is exhausted at tailblock end into small ventilation drifts running underneath across ends of scrams. Fans, rated at 60,000 cfm, discharge into main laterals and air is discharged to surface or recirculated through sprays.



UNDERCUTTING consists mostly of inclined openings which do not require mucking equipment. Blasting is timed to start row retreating from caved area. Drilling equipment consists at brow holes over drawhole and go up to apexes and finally reach doghole. Over-all scheme is to remove pillars in single of column and arm mounted drifters and sectional steel.





DESIGN for full gravity branch raise layout was developed over some 22 years of practice. Height of ore caved from individual blocks was planned at about 300 ft. Original pillars between blocks were 15 ft wide but 30 to 50 ft proved more effective in preventing dilution from adjoining mined-out areas. Later design using lateral transfer of ore by slusher rather than branch raises was demanded by lack of vertical distance between bottom of ore and lowest level. Shaker conveyors were also tried for a time. Since 1947 most of tonnage has come from such slusher blocks. Next development was use of belt conveyors in place of rail haul for gathering ore from slusher dump raises. Belt required smaller drifts and permitted moving rail haulage drifts completely out from under slusher blocks in weak ground without adding to height requirements. Since 1949 about half of slusher blocks have used belts for stope haulage. Success of belts and slushers apparently resulted in further use as shown at right which eliminates most of rail haulage on all except main 1,000-level.

Miami Uses Slusher And Belt-Conveyor Scheme

Miami Copper Co., Miami, Ariz.

GEOLOGY:

Ore is largely in pre-Cambrian Pinal schist intruded by Tertiary Schultz granite porphyry and covered to some extent by Quaternary Gila conglomerate. Structures are highly faulted and shattered. Miami fault cuts off ore on east. Pinto fault on southwest caused reoxidation of enriched sulphides, producing mixed ore. There was secondary ore enrichment by descending solution of low grade copper bearing pyrites. Minerals are mainly chalcocite with chalcopyrite, bornite, covelite, copper oxides, native copper and molybdenite. Ore minerals occur in seams, veinlets and disseminated particles. Average copper content is about 0.8%. Orebody is roughly triangular in plan—3,700-ft base, 2,500-ft altitude with apex to south. It is about 350 ft thick and overlaid by 250 to 500 ft of barren capping.

Height of ore caved: 150 to 600 ft.

Thickness of capping: averages 500 ft.

Single caving unit, horizontal dimensions: stopes—150 x 150 ft, pillars —37½ x 75 ft.

SEQUENCE OF OPERATIONS in bringing unit into production:

Drive haulage drifts.

Drive fringe drifts on grizzly or slusher level.

Drive raises from haulage level to grizzly or slusher level.

Drive grizzly or slusher drifts.

Drive finger (control) raises from grizzly or slusher level to undercut (mining) level.

Drive undercut (mining) drifts across tops of finger (control) raises.

Widen undercut drifts, drill and blast pillars.

Smallest area required to start caving action: depends entirely on type of rock.

BOUNDARY CUTOFF SCHEME:

In soft or medium rocks stopes a corner raise is driven 30 ft above top of finger in each corner. In extremely hard rock a boundary cave drift is driven completely around stope, 40 ft above undercut.

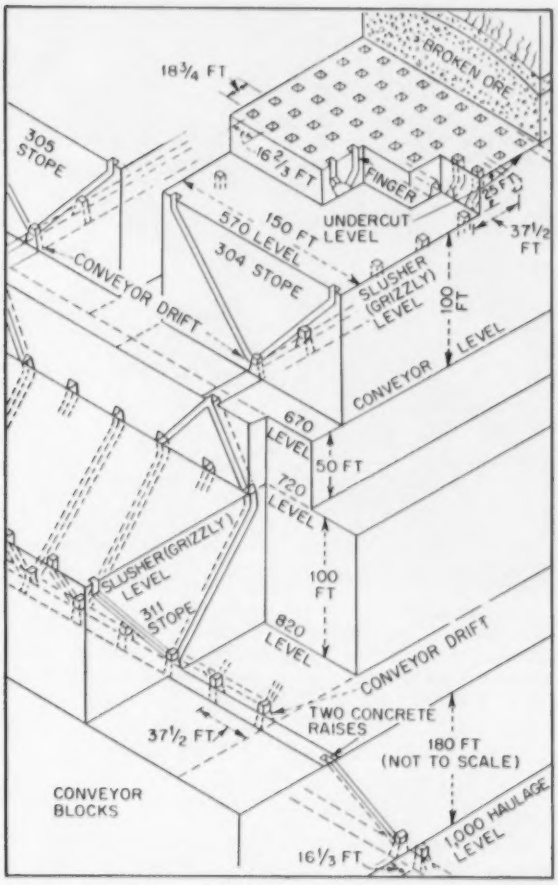
GROUND SUPPORT:

In haulageway: 10x10-in. timber.

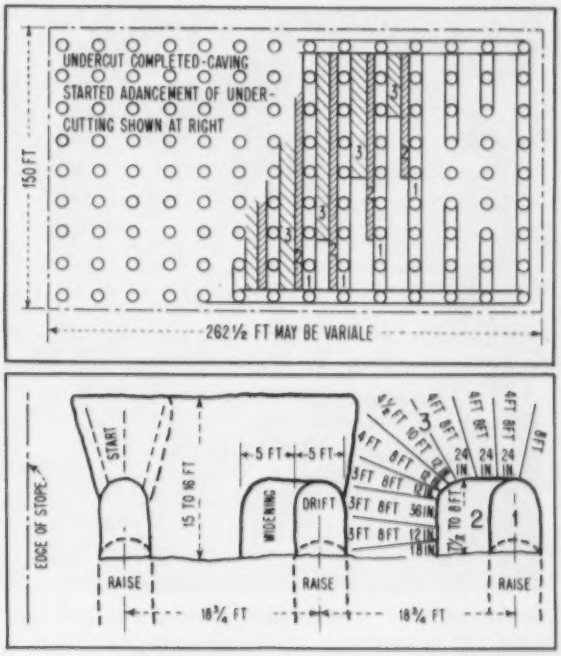
In grizzly and slusher drifts: 10x10-in. timber or 4-in. (13 lb, WF) circular steel sets 6½-ft dia with 5- to 6-in. round lagging.

In undercut: 6-in. round temporary timber.

In raises: 6x12-in. cribbing reinforced with 3-in. angle iron wear collars.

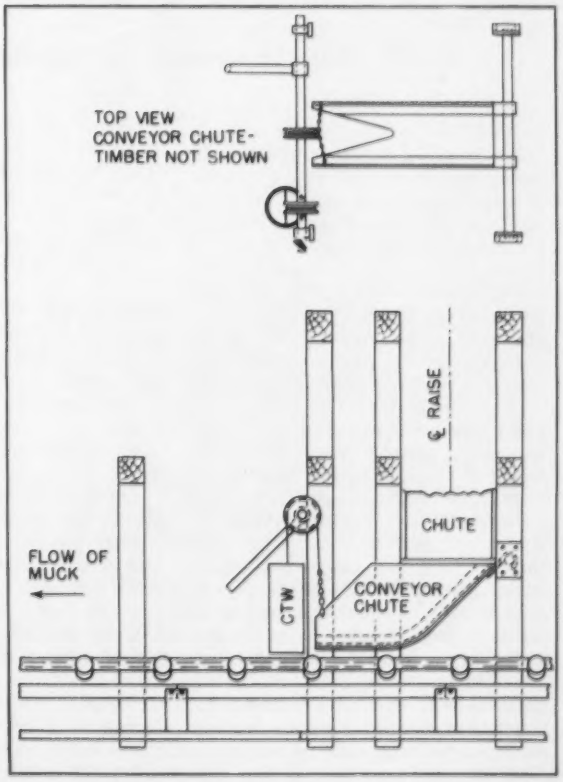


LATEST LAYOUT has slusher-gravity-belt conveyor scheme and utilizes tricky ore pass arrangement.



UNDERCUTTING methods (above) starts with driving drifts across tops of fingers. Before all drifts are completed, drifts at one end of block are widened and pillar blasted.

CONVEYOR CHUTE GATE (below) cuts impact on belt.



ORE GATHERING:

Draw control: uniform draw over entire stope. Draw based on 9 vertical inches of ore in place per 24-hr day equivalent to about 1,800 tons per day for 150x200-ft stope. Draw may go up to 18 in. if weight on accessways becomes excessive, or slow down if dilution appears.

Draw angle: vertical.

Area per drawpoint: 312½ sq ft (16⅔ x 18¾ ft).

Drawpoint discharge opening: width—4ft, height—6 ft.

Grizzly & slusher dump opening: 4x4 ft with rails spaced for 10-in. clear openings.

Slusher bucket: 42 in. wide by 24 in. high, rigid hoe (Pacific) moves ½-ton per pass.

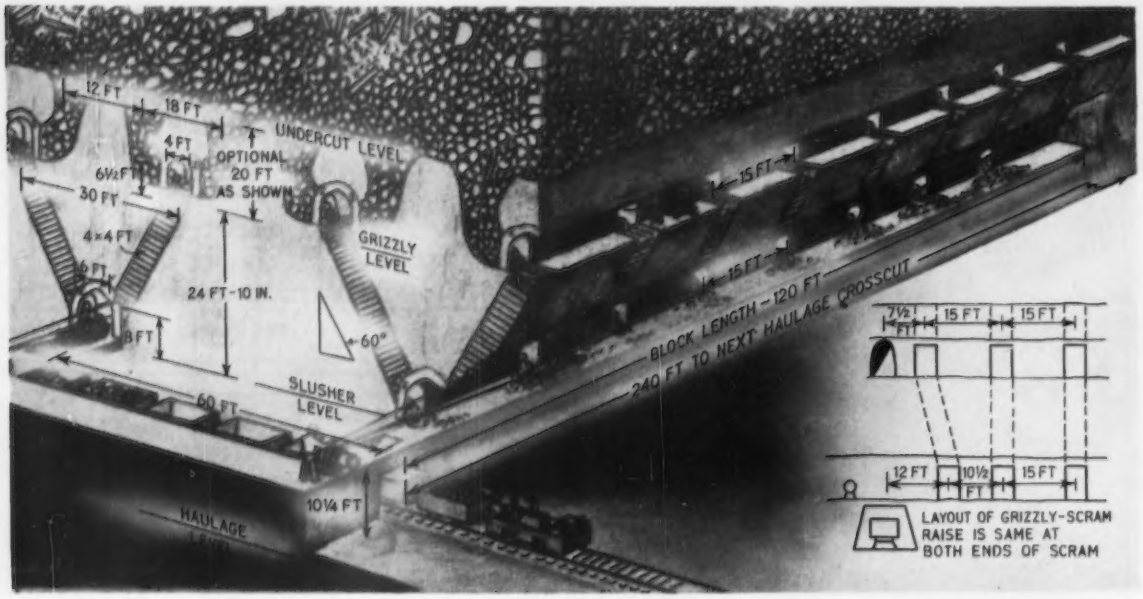
Slusher hoist: double drum 25 hp (Joy).

Car loading chute gate: arc gate and special gate for loading conveyors.

Haulage: 30-car trains, 86-cu ft (4-ton) gable bottom cars with two 6-ton trolley locomotives in tandem; supplemented by belt conveyors.

VENTILATION:

Fresh air enters by No. 5 and No. 9 shafts, 40,000 and 70,000 cfm respectively. It flows generally downward and toward one end of mine through access openings. Exhaust is up No. 7 shaft through 110,000-cfm exhaust fan on surface. Auxiliary 10-hp fans are used to regulate air flow underground.



BASIC LAYOUT of combination slusher-gravity system with grizzly drifts parallel to slusher drifts is only one design developed from original all gravity branch raise scheme. Slushers lend themselves to high yet well controlled production. Straight raises without chute gates efficiently pass sticky as well as large size muck. Grizzlies size ore for maximum scraper efficiency. Number of both grizzlies and drawpoints per scram permit flexibility of draw distribution without interrupting slusher operation. And drawpoint spacing gives good draw control for size of muck.

Butte Combines Gravity and Slushing

Kelley Mine, Anaconda Co., Butte, Mont.

GEOLOGY:

Ore is related to branching and interlacing structures of different ages within large mineralized area of intensely fractured and altered quartz monzonite. Sulphides, oxidized up to several hundred feet in depth, occur in veins, stringers, ore chutes and disseminated grains which combine to make mineable ore zones. Minerals are pyrite, enargite, bornite, chalcocite and chalcopyrite. Average grade of mineable orebodies is at least 1% copper with minor amounts of silver and gold. Orebodies (zones) were previously mined and contain timber, rockfill and tailings. Moisture, about 4%, and presence of clay minerals results in sticky ore that is difficult to pass through gates and causes packing in drawpoints. Bodies are fairly regular in plan—100 to 400 ft wide and up to 1,600 ft long—dipping 65 to 90 deg and from several hundred to over 1,600 ft in vertical dimension. They contain from 2- to 60-million tons. Capping is granite, generally leached of any sulphides, and overlain by alluvium.

Height of ore caved: 100 ft minimum, 560 ft maximum.

Thickness of capping: 100 to 1,000 ft.

Single caving unit, horizontal dimensions: block as small as 80x90 ft where necessary, and as large as 120x120 ft where possible.

SEQUENCE OF OPERATIONS in bringing unit into production:

Develop haulage crosscut, generally with timber support.

Excavate and concrete slusher stations.

Excavate and concrete slusher drifts, leaving windows for raises.

Drive main raises to grizzly level, timber support where necessary.

Excavate and concrete grizzly drifts and grizzly fringe drifts, leaving windows for finger raises.

Drive finger raises.

Drive undercut drifts.

Do boundary weakening where necessary.

Remove pillars on undercut from broken to solid side, plus or minus 1,000 sq ft per blast.

Smallest area required to start caving action: 100 sq ft up to 3,600 sq ft.

BOUNDARY CUTOFF SCHEME:

Only in firm ground, generally on footwall side of block. Drive vertical and inclined raises on solid corners only, then slash. Cutoff does not generally exceed 30 ft vertically from undercut.

GROUND SUPPORT:

In haulageway: 10x10-in. timber, 5⅓-ft centers.

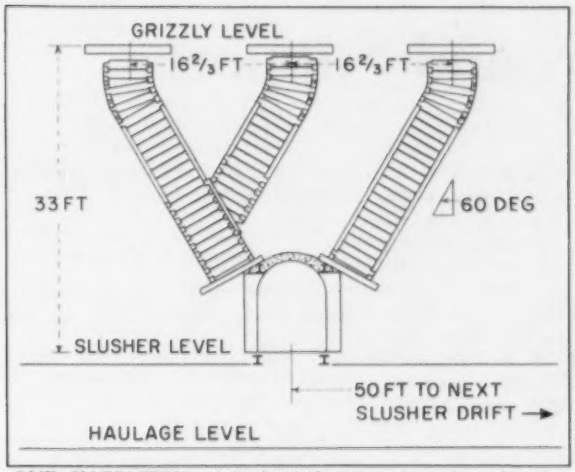
In slusher and grizzly drifts: 16-in. thick concrete arch.

In undercut: temporary stulls.

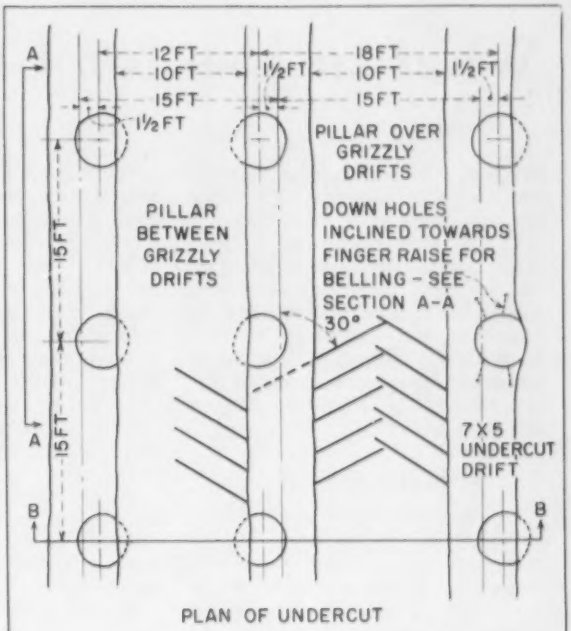
In raises: 5x10-in. cribbing where necessary.

ORE GATHERING:

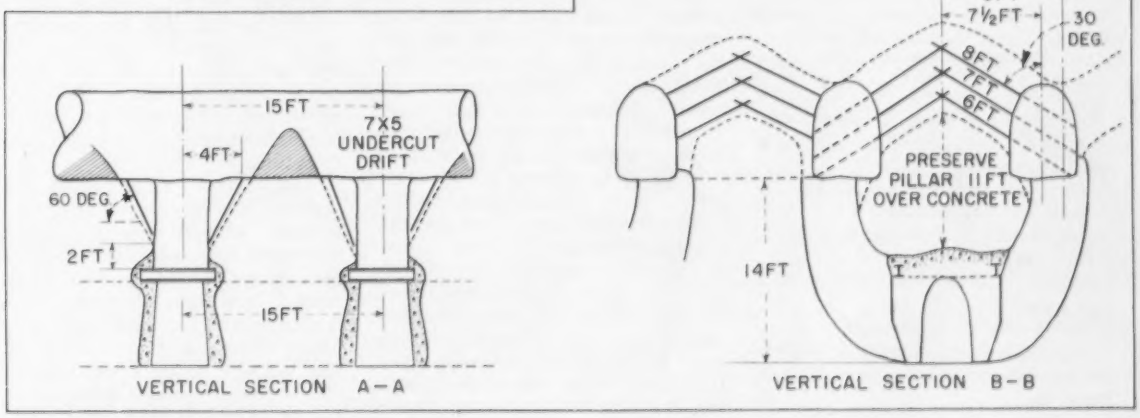
Draw control: Each block mined as unit and draw distribution plan depends on conditions adjacent to block being mined. Draw averages about 1 vertical foot of ore in place per production day equivalent to about 20 tons per finger per day. But it may exceed 2½ ft or 50 tons to prevent packing or excessive weight.



ONE VARIATION of basic design has three branch raise arrangement, vertical raise section under grizzly and grizzly drifts transverse to scrams. With grizzly drifts still at 30-ft centers, drawpoint area increases very slightly but distance between openings into scrams doubles. Latter result plus increase in height between grizzlies and scram, makes stronger pillar. Vertical section in raises was designed to reduce packing of muck. Latest variation in design has drawpoints opening directly on scram.



PLAN OF UNDERCUT



UNDERCUTTING operation has also varied. In scheme shown above, initial undercut drifts are driven parallel to grizzly drifts to connect tops of previously excavated finger raises. Earlier scheme was to drive undercut drifts at right angles to grizzly drifts. Latter procedure requires longer raises to give desired pillar over grizzly drift concrete.

Airleg drills are now used, giving more than double drift footage per shift as compared to stopers.

After drifting is completed—including crosscuts across ends and through middle of block—remaining pillars are removed by drilling and blasting in herringbone pattern (shown above). Work retreats from face of block exposed to broken ground.

Draw angle: vertical.

Area per drawpoint: 240 sq ft.

Drawpoint discharge opening: width—4 ft, height—6 ft (at grizzly).

Grizzly opening: 4 ft x 4 ft-10 in. with rails spaced for 16-in. clear openings.

Slusher dump opening: 3½x3½ ft.

Slusher bucket: 60 in. wide folding (Eimco) moves about 2¾ tons per pass.

Slusher hoist: double drum 75 hp (Ingersoll-Rand; Joy; Vulcan).

Car loading chute gate: none, direct loading by slusher.

Haulage: 20-car trains, 115-cu ft (5-ton) Granby-type cars (Lakeshore; Card) with 10-ton trolley locomotives, 125 hp (Westinghouse).

VENTILATION:

Fresh air from main shaft, exhaust air to surface through raise system and surface exhaust fans. Fresh air flow per grizzly drift is 5,000 cfm. All polluted air is routed around working areas. Auxiliary fans, 3,000 to 6,000 cfm, and ventilation tubing used for development work. Dust collector at car dumping stations and skip loading stations. Joy Microdyne dust collector now being applied to some mining blocks and localized dust sources.

What to Use for Ground Support

PRIMARY PURPOSE of ground support and control in mining is to maintain openings in the earth long enough to permit safe extraction of ore. We must have the openings to get at the ore, we must keep them open long enough to remove the ore and we must have openings that can be relied upon during removal. With these requirements established, choice of support depends on cost, ground stress and mining method.

Factor I: Cost

Selecting the means of supporting an excavation in the earth involves many factors. In a mine, the ultimate factor is over-all cost per ton of ore produced. As for any task or product, in determining over-all cost one must consider the costs of raw material, labor, equipment and power required. For the cost of mine supports, the major elements of concern are:

Initial cost of material—availability.

Fabrication—equipment and labor skill required.

Handling and transportation—size, weight and equipment.

Installation—simplicity, time and equipment.

Life — maintenance, replacement and reuse.

Bulk—related to strength and efficient application of material and affecting excavation size and ease of handling.

Factor II: Ground Condition

The second principal factor is undoubtedly concerned with the ground. A simple, practical approach is to consider five conditions:

(1) When rock flows more or less as a plastic material.

(2) When rock acts similar to a pile of irregular, interlocking blocks.

(3) When rock is weakened, spalls or swells due to contact with air or moisture.

(4) When rock spalls or bursts due to high pressures.

(5) When rock is fully self-supporting.

A similar approach was voiced by R. W. Edwards in a paper given at American Mining Congress, October 1956.

When ground stress is high enough to develop a plastic condition in the rock, no support is able to fully and indefinitely resist the rock pressures although some retarding effect may be possible. In this case provision should be made only to absorb the deformation and slow it down, with wood squeeze blocks or cribs, loose fill or yieldable members.

In blocky ground, rigid support quickly emplaced will hold the rock and tie it together to prevent further movement.

For air-moisture problems, sealing the surface or light support of the products of the process — which in turn seal the surface—is usually sufficient.

If rock spalls or bursts, supports may help but generally the condition is more chronic and requires some method of destressing the rock before attempting support. Drilling and blasting deep within the face has been fairly effective. Eliminating small, irregular projections is another means.

And finally when rock is fully self-supporting there is no problem.

More comprehensive knowledge of ground stress and rock mechanics is highly desirable but it is a complex and still debated subject that can not be adequately covered here. In the past few years some excellent reports on current views have been published. Among them are: "Canadian Mining and Metallurgical Bulletin" Nov. 1955, Jan., Feb., Mar., Apr., June and Nov. 1956; "Mine and Quarry Engineering" (London) May, June and July 1955 and Apr., May and June 1956; and "Colorado School of Mines Quarterly" July 1956. While none of the work has yet been able to bring the various factors into relatively simple relationships such as are available for common materials of construction, there are some workable formulae that warrant study.

Factor III: Mining Method

The third major factor concerns the mining method. Neither support nor mining method can be selected independently. Wise selection of method can reduce support problems and wise selection of support can make cheaper methods feasible.

Some of the considerations involved are:

Whether shaft, tunnel or stope type openings are concerned.

Whether support is needed temporarily or permanently, and

Whether support is required at a point, along a line or over an area.

In addition, attention must be given to safety—reliability, resistance to decay and fire, etc.

Shafts, tunnels or stopes all present the same problem of holding the ground open until the ore is removed. Compared to extraction openings, accessways are usually more permanent, have more critical features of rigidity (alignment), must be continuously supported to prevent even small falls of ground at any point but have smaller spans to be supported.

Beyond the fundamental need of holding ground open long enough to permit extraction, certain other factors may influence the requirement for permanence, such as: ventilation, prevention of water influx and surface subsidence which might result from collapse, etc.

Point, line or area support is influenced by rock structure as well as method. Strongly cohesive, massive rock tends to require only point support (props, bolts, etc.). Weak or thin bedded rock indicates need for line type support (bars; sets; etc.). And highly fractured ground will require area support (continuous lining, fill, pillars, etc.). Of course, point supports can be spaced to give a line support and line supports can be spaced to give area support.

On the following three pages are a few of the many products related to ground support that are available from some of the manufacturers listed in our Buyers' Guide. It is impossible to go into the advantages, disadvantages and special features of all such products. Only typical types are presented. More details and variety can be found in the many excellent brochures and catalogs available from the manufacturers.

It will pay to keep in mind that the primary function of most ground support is to aid rock in supporting itself, that even a small confining pressure greatly increases the strength of rock and hence its ability to carry a load, and that the smaller the opening the smaller the problem.

Rockbolts Are Versatile

ECONOMIC ANSWER to ground support at many mines are rockbolts. Most common practice is to use bolts about 5 ft long on about 4-ft centers. Permissible load for rigid support is about 5 tons per bolt with present designs. Principal advantages are ease of installation and small bulk. The latter permits smaller excavations and makes handling easy.

Bolts themselves are usually classified into two general types based on anchoring device—slot-and-wedge (Fig. 1) or expansion shell (Fig. 2). Head (exterior end) is next major distinguishing feature—threaded (Fig. 1) or integral nut (Fig. 2). Slot-and-wedge type bolts all have threaded heads. Expansion shell type bolts can have either, depending on type of plug (wedge) used to expand shell. Threaded head is used if integral plug is formed on interior end of bolt (Fig. 3 and 4). Integral nut head is used with nut plug (Fig. 2, 5 to 7, 9), in which case there are threads on interior end of bolt. Integral nut head bolts come in two styles—with (Fig. 7 and 8) or without (Fig. 2, 5, 6 and 9) ears (lugs) just below interior threads. Need for ears depends on whether shell itself is bail type (Fig. 5 and 6) or non-bail type (Fig. 7 and 9). Non-bail type requires some means of keeping shell from sliding along bolt during installation and either ears (Fig. 7 and 8) or lock nut (Fig. 9 and 10) is used. In addition to various designs of expansion shells, wedges for slot-and-wedge type bolts come in various designs.

Variety of washers, plates and spreader products are available. Two recent developments are T-hole plate (Fig. 11) used on integral nut headed bolts, and chain-link fencing (Fig. 12) used as lagging. Extension rods for both slotted and expansion bolts are all available. Tension indicators (Fig. 13) flatten at proper bolt tension when placed between head nut and plate, and become curved again when tension is lost. Pull testers (Fig. 14), are used to spot check anchorage. Other types are being developed. Aids such as torque measuring wrenches and gages to check depth and diameter of hole are also worth investigating.

Rock drills especially adapted to rock bolting are supplied by many drill manufacturers. Impact wrenches also are useful.

Concrete grout has been found highly successful in anchoring bolts and wire rope in weak ground in Scandinavia. Perfo method of Sika Chemical Corp. was described in *E&MJ* September 1956. USBM is testing resin.

Fig. 1 Bethlehem Steel

Fig. 2 Colorado Fuel & Iron

Fig. 3 Republic Steel

Fig. 4 Pattin Mfg.

Fig. 5 Ohio Brass

Fig. 6 Bethlehem Steel

Fig. 7 Bethlehem Steel

Fig. 9 Ohio Brass

Fig. 12 Colorado Fuel & Iron

Fig. 14 Continental Gin

Fig. 8 Republic Steel

Fig. 10 Palnut Co.

Fig. 11 Bethlehem Steel

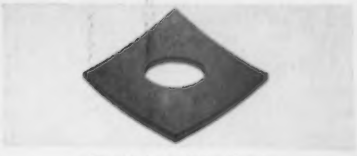


Fig. 13 Amer. Mine Supply

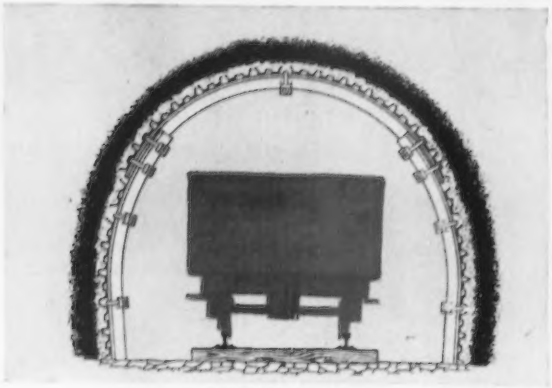


Fig. 15 Bethlehem Steel

Fig. 16 Herold Mfg.

Steel Yieldable Sets and Liner Plate Combat Special Conditions

YIELDABLE STEEL ARCH SETS are a fairly recent development of special advantage in heavy squeezing ground. They have proven highly successful for slusher drifts in block caving. Replacement and maintenance is almost eliminated and recovery is often possible. Semi-circular arches (Fig. 15) are often sufficient. In other cases full rings (Fig. 16) are needed. Spacings of 2 to 6 ft have been used.

Fig. 17 Comm. Shear & Stamp.

Fig. 18 Armco

Tunnel liner plate (Fig. 17 and 18) fills the bill for vertical as well as horizontal openings through running ground. Designed as structural members themselves, they need no additional support.

Joining is an essential element of working with steel. Bolted, riveted and welded connections are common. Studs of various styles come in handy. Powder activated stud drivers (Fig. 19) are available in several sizes. And a welding type (Fig. 20) is now available too.

Fig. 19 Remington Arms

Fig. 20 Nelson Stud

Fig. 21

Fig. 22

Fig. 23

Fig. 24

Fig. 21 and 22 Herold Mfg. Fig. 23 Nat. Mine Serv. Fig. 24 Templeton, Kenly

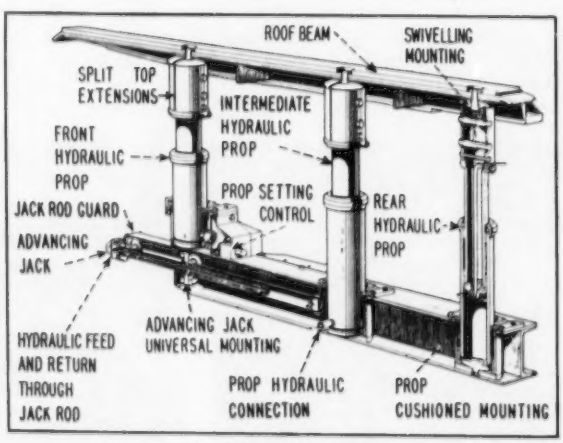


Fig. 25 Dowty Mining Equip.

Steel Props Deserve A Look

TEMPORARY SUPPORT needs can often be met with props. Steel ones are easily installed and recovered. Wedge type (Fig. 21) has yieldable feature. Jack types give quick support. Ten-ton capacity is common. Standard ratchet types as well as special adaptions (Fig. 22) are offered. Screw types are widely used. Some have feature for using wall pin as base (Fig. 23). Others have special means of turning screw (Fig. 24). Hydraulic types are efficient and are used in most mechanized props (Fig. 25) such as are being developed in Europe.

Concrete Has Proven Itself

CAST CONCRETE'S permanence, general utility and low over-all cost has made it a major support material.

Additives for improving various qualities of concrete are coming into wider use. Among those offered are those which cut segregation, stop shrinking, improve slump for easier handling without requiring additional water and speed setting.

Precast reinforced shaft set members have been used and the recent use of prestressed members (Fig. 26) show considerable promise for horizontal openings too. Precast laths are in use as lagging and concrete block have been used for linings and support packs.

For casting in place, small mobile mixers and placers can be used underground if volume is moderate or demand is intermittent. Large surface mixing plants with pipelines to large centrally located underground placers have been found advantageous for large volume production.

Fig. 26 Elgin

Forms are an important element. Prefabricated ones of steel have economies. In circular shafts, sliding forms have come into use. In haulageways, mechanized steel forms (Fig. 27) are useful. In less accessible openings, aluminum fabrication makes handling easier.

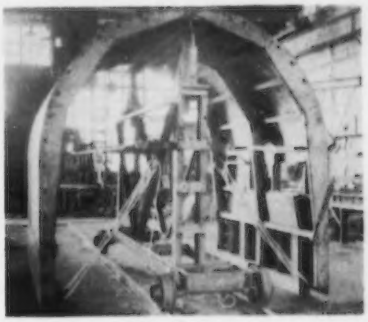


Fig. 27 Mayo

Pressure grouting is an effective means not only of sealing off water but also of tying fractured ground together into a self-supporting unit.

Gunned concrete grout is used to seal surface against air and moisture slaking and when used with wire mesh, gives a supporting effect.

Timber Is Still Major Material

AVAILABILITY and related low initial cost in most regions as well as simplicity of working makes wood an invaluable means of support. Repairs are easy and it gives audible and visible evidence of excessive load or ground movement.

Decay generally limits its life but preservatives have largely removed that disadvantage. Compounds are offered for painting, spraying, soaking and pressure impregnating. Complete coverage is important. Relatively simple equipment for impregnating using osmotic effect lends itself to underground installation.

Timber framing machines (Fig. 28) have cut requirements for highly skilled workers and thus promote continued use. Improvements in handling and storage such as strapping complete sets into bundles, using forklifts and using special timber cars that can be slung below cage while fully loaded have also helped.

Timber connectors are being found useful. Spiked grids (Fig. 29), rings in grooves, framing anchors and other types are designed for specific uses.

Fig. 28 Stearns-Roger

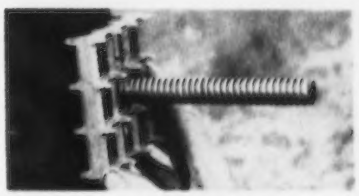


Fig. 29 Timber Engrs.

Rock Is Important For Pillars And Fill

LEAVING ROCK PILLAR is simplest way of supporting ground. Three considerations are: value of mineral, span rock will stand unsupported and size of pillar required. Size of pillar of course depends on load and strength of rock but is influenced by evidence that area of individual pillar is more critical than total area of all pillars. Wrapping with wire rope has been used to develop lateral confining stress that additional rock would normally develop.

Hydraulically placed sand fill has many advantages. Among them are: ease of handling; makes tailings disposal simple; and gives strong, dense support that follows ground irregularities. Permeability of sand is important since quick drainage of initial water and any later influx is essential for strength. Cyclones are economical tool for desliming and controlling pulp density. Flocculants speed drainage. Electro-osmosis has been suggested as drainage aid recently.

Plastic, Resin And Glass Are Newcomers

PLASTIC COMPOUNDS have been found low cost for sealing rock surfaces in coal mines. Resins are reported as being tested as grout for anchoring rockbolts and for ground stabilization. Plastic bonded fiber-glass rock bolts are likewise under test. Plastic has also been used to preserve wood.

Today's Fans Meet Exacting Ventilation Needs

THE CHECK CHART below shows what basic types of fans are available today for mine ventilation, both primary and auxiliary, and for service in surface plant buildings. Manufacturers have made many improvements in fan design and construction in recent years, including even a modified "feathering" feature which permits changes in blade pitch, making the axial-flow type fans as efficient as the propellers of modern aircraft. This makes it possible to select a fan with assurance that it will provide adequate ventilation at high efficiency for any project it is chosen to serve.

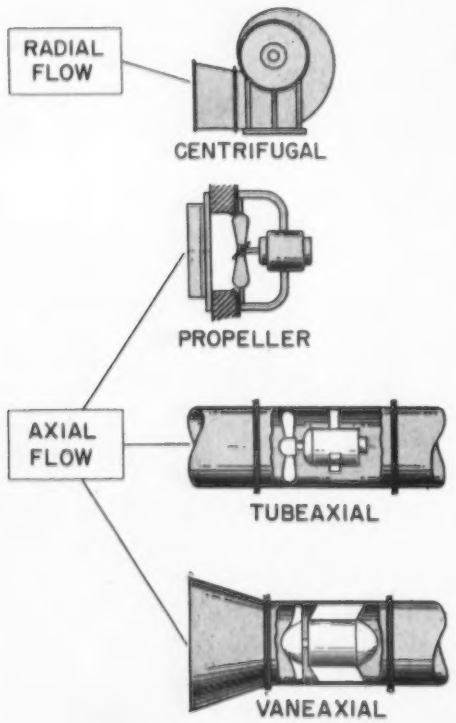
In general, centrifugal and axial-flow fans are comparable in efficiency and sound, though latter offer the advantage of being lighter and requiring less space, especially if arranged for straight through operation. An example of this will be found in the section showing modern fan layouts following. Fan drives include belt and direct connected, the motive power in most instances being electric motors. Where no electric power is available, fans installed at tunnel portals are driven by gasoline or diesel engines. Some auxiliary units are compressed air driven. Dependability in fan service can be assured through employment of auxiliary drives in standby service.

Manufacturers also have made great progress in perfecting better ventilating materials other than fans. Included in these are improved curtain materials, such as treated cloth and neoprene-coated types, and for stoppings telescopic metal sections, sheet plywood and plastic sheeting, as well as inflated stoppings. Advantages obtained thereby are rapid installation for savings in labor and full reclamation for savings in supply costs.

Better ventilation of headings, raises and stopes has been achieved through improved tubing serving auxiliary fans and portable units. Material used today in flexible tubing and metal conduits include canvas (treated), canvas reinforced (spiral wire core), synthetics such as Neolon and others, galvanized iron, spiral lock, aluminum, etc. Special connectors, grommets and hooks facilitate rapid installation and removal to other locations.

Prefabricated corrugated pipe sections are being used to construct air bridges, thus cutting the cost of such construction and permitting the use of more overcasts to the exclusion of doors and other wasteful air-current controls. As a result, overcasts are no longer frowned upon in designing ventilation systems. They are used more and more in modern mines as the best means of pumping air into the returns with least trouble or of initiating splits.

Fan Types and Their Operating Principles



THIS TYPE OF FAN is designed to move air or gas over wide volume range. General static pressures go up to 25-in. water, some special fans to 90-in. Impeller has straight, forward-curve, backward-curve, radial-tip or other type blades. Housing is sheet or cast metal with or without protective rubber or metal coating. Belt or direct drive.

THE PROPELLER-TYPE FAN can move air from one enclosed space to another or from outdoors to indoors or vice-versa in a wide range of volumes at low pressures (0 to 1-in. water). Adjustable blades. Belt or direct driven.

IN THIS DESIGN AXIAL-FLOW IMPELLER in cylinders moves wide range of air at medium pressures (¼- to 2½-in. water). Adjustable blades. Fan may be mounted in air duct. Blades may be disk or airfoil type.

THIS FAN TYPE has set of air guide vanes mounted in cylinder before or behind airfoil-type impeller. It can move air over wide range of volumes and pressures from ½- to 6-in. water. Special designs go up to 60-in. or higher. Adjustable blades. Belt or direct driven.

Centrifugal-Fan Multirating Table

Wheel diameter = 60 in. Outlet area = 20.64 sq ft

Outlet velocity, fpm	Capacity, cfm	½ in. SP		¾ in. SP		1 in. SP		1½ in. SP		2 in. SP		3 in. SP	
		rpm	hp	rpm	hp	rpm	hp	rpm	hp	rpm	hp	rpm	hp
1100	22,704	236	2.68	268	3.73	296	4.84	347	7.29				
1200	24,768	246	3.05	276	4.16	303	5.37	352	7.89				
1300	26,832	256	3.48	285	4.66	312	5.91	359	8.56				
1400	28,996	266	3.96	294	5.21	320	6.51	366	9.30	407	12.2	483	18.8
1500	30,960	277	4.50	304	5.79	329	7.19	374	10.1	414	13.2	488	19.9
1600	33,024	288	5.10	314	6.45	338	7.91	382	10.9	421	14.2	493	21.2
1700	35,088	300	5.79	325	7.14	348	8.66	391	11.9	429	15.2	497	22.5
1800	37,152	312	6.53	336	7.95	358	9.51	400	12.8	437	16.3	505	23.6
1900	39,216	325	7.04	347	8.80	368	10.4	409	13.9	445	17.4	511	25.1
2000	41,280	338	8.30	358	9.75	379	11.4	418	15.0	454	18.7	519	26.6
2200	45,408	364	10.37	382	11.9	401	13.7	438	17.4	472	21.5	535	29.9
2400	49,536	391	12.80	407	14.5	425	16.2	459	20.2	493	24.4	553	33.4

Vane-axial-Fan Rating Table

All these fans turn at 1750 rpm

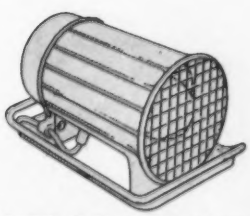
Fan dia, in.	.5 in. SP		1.0 in. SP		1.5 in. SP		2.0 in. SP		2.5 in. SP		3.0 in. SP	
	cfm	hp	cfm	hp	cfm	hp	cfm	hp	cfm	hp	cfm	hp
18	3260	.7	2900	.75	2500	.8						
22	5800	1.85	5400	1.9	4950	1.9	4250	2.0	3250	2.0	1850	1.85
25	8200	2.25	7750	2.65	7250	2.9	6750	3.05	6000	3.1	4500	2.9
25	10450	3.9	10000	4.1	9500	4.3	8950	4.5	8200	4.6	7000	4.4
29	13650	4.5	12800	4.65	11800	4.8	10750	4.95	9500	5.0	7700	4.9
29	15000	5.2	14300	5.7	13500	6.1	12700	6.5	11800	6.8	10900	6.9
29	17500	7.5	16800	7.7	16000	7.85	15100	8.0	14200	8.3	13150	8.4
32	17000	7.5	16400	8.0	15800	8.6	15200	9.0	14550	9.5	13900	10.0
32	22200	12.2	21600	12.5	21000	13.0	20400	13.4	19500	13.8	18700	14.1
34	29200	17.6	28450	18.4	27600	19.0	26800	19.6	25800	20.2	24800	20.8
36	31300	17.0	30500	17.8	29600	18.6	28600	19.4	27500	20.0	26700	20.6
36	40500	24.0	39200	24.5	38000	25.0	36400	25.0	34600	25.5	32800	26.0

(From Power's Handbook on Fans)

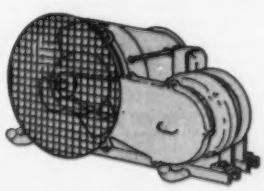
Here's how to use above fan rating tables.

If rpm and hp of a centrifugal fan which must deliver 33,000 cfm at 1-in. static pressure, and 1600 fpm outlet velocity are wanted, then take from respective table unit that closely meets these conditions, or 33,024 cfm. Under 1-in. SP, rpm is 338 and hp is 7.91. In the case of a 40,000-cfm unit at 2½-in. SP, the way to find rpm and hp is by taking nearest fan capacities in table—39,216 and 41,280 cfm, and interpolate. At 2-in. SP, rpm is $445 + \frac{40{,}000 - 39{,}216}{41{,}280 - 39{,}216}(454 - 445) = 448$. Horsepower input is $17.4 + \frac{40{,}000 - 39{,}216}{41{,}280 - 39{,}216}(18.7 - 17.4) = 17.9$. Like interpolation can be made for other capacities and pressures. Procedure differs little for vane-axial fans. If hp and rpm are wanted for a unit which must deliver 15,000 cfm at 2-in. SP, the respective table will show that a 15,100-cfm fan at 2-in. SP requires 8 hp, turns at 1,750 rpm, and has a 29-in. diameter. Tables for propeller fans are similar to vane-axial-fan rating table but usually include a column for capacities and free delivery (no resistance). For special fan layouts (fans in series, etc.) consult the manufacturer.

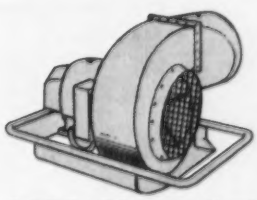
Panorama of Auxiliary Fans



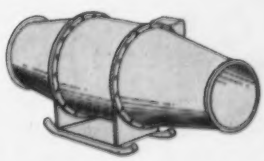
PORTABLE direct-driven Aerodyne blower for use with 12-in. tubing.



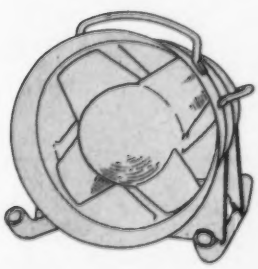
AXIVANE V-belt-driven portable blower. Can be fitted with airmotor drive.



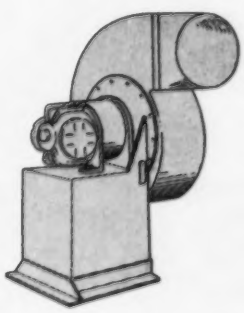
PORTABLE centrifugal blower. Cast aluminum forward blade fan wheel mounted directly on motor shaft.



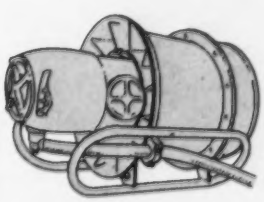
SKID-MOUNTED blower for use in tubing line to reduce pressure and leakage.



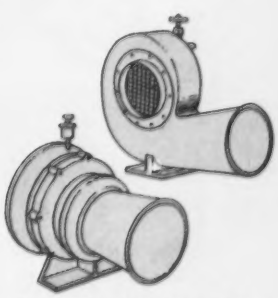
INTAKE portable tubing blower. External lubrication fittings.



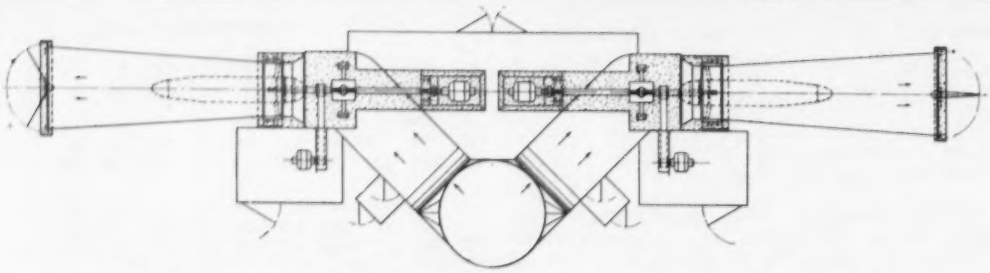
DIRECT-DRIVEN, 45-deg adjustable centrifugal discharge blower.



PORTABLE AXIVANE blower with motor mounted on propeller shaft.

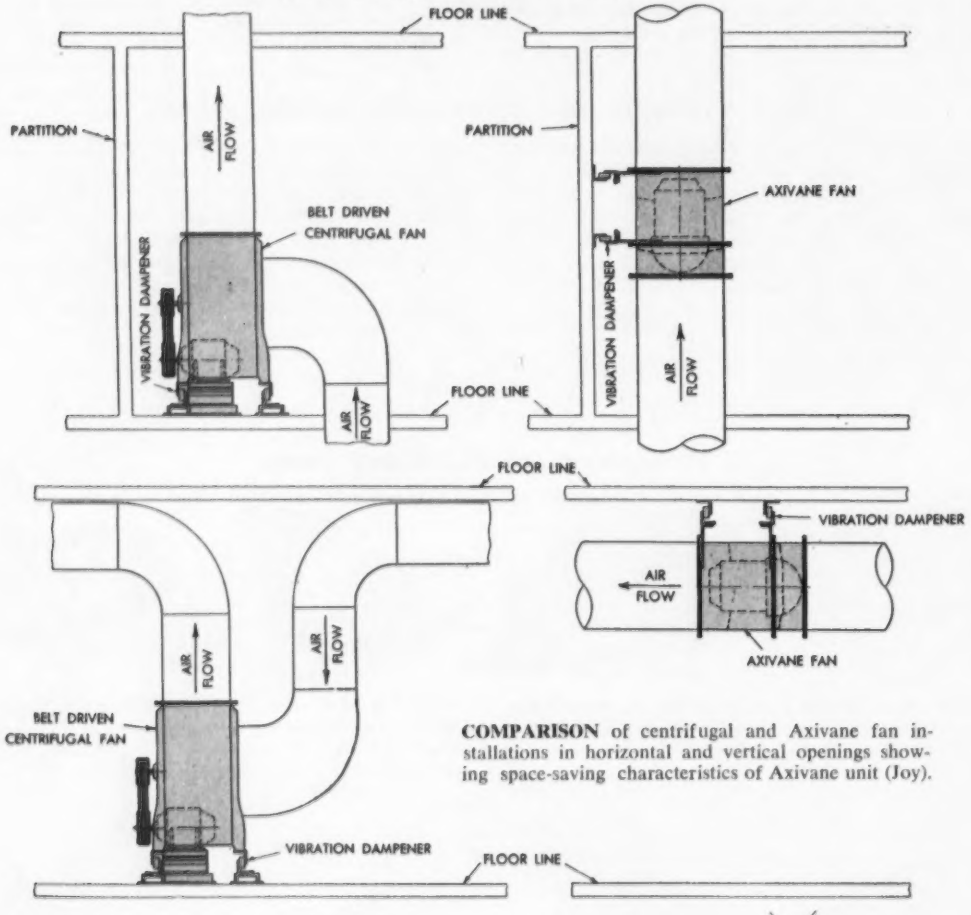


COMPRESSED AIR-DRIVEN VENTAIR and VANO portable blowers. Can be provided with motor drives.

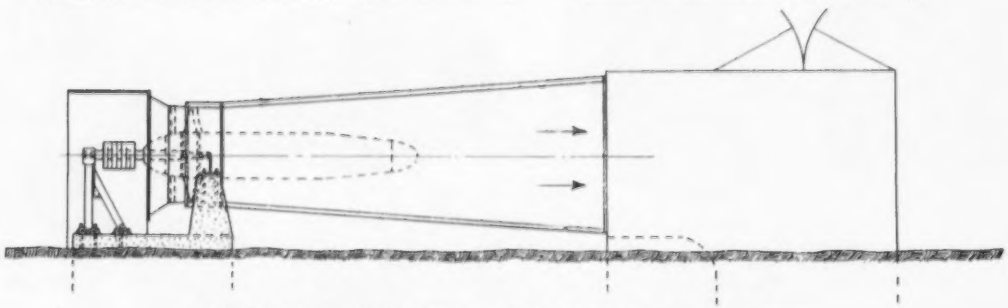


TWO PARALLEL AERODYNE exhaust fan installations (plan view) at collar of air shaft. Layout design is dictated by limited space due to topographical conditions (Jeffrey).

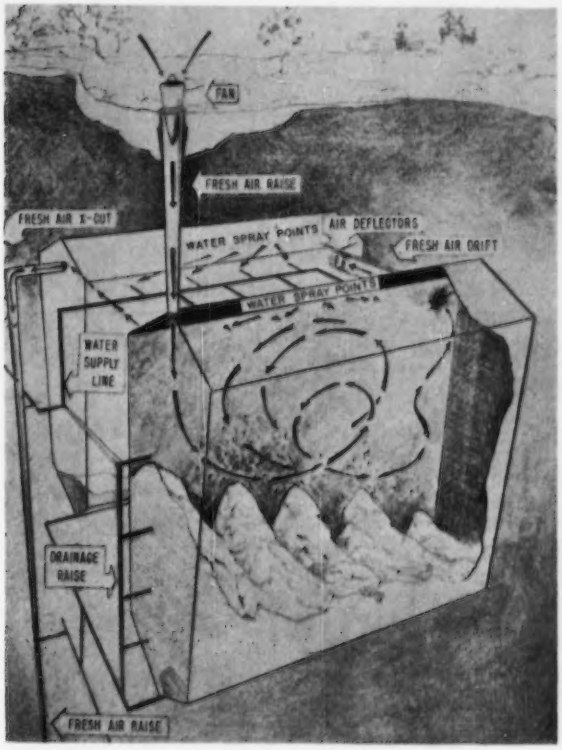
Some Unique Fan Installations



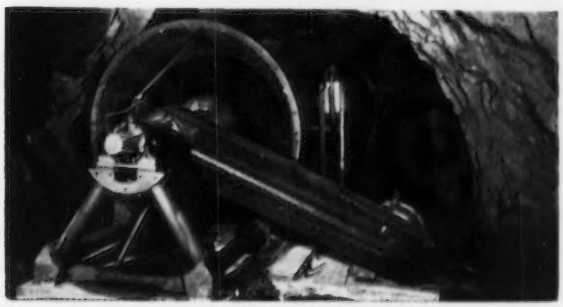
COMPARISON of centrifugal and Axivane fan installations in horizontal and vertical openings showing space-saving characteristics of Axivane unit (Joy).



AERODYNE BLOWER fan installation (elevation with drive protected from weather by steel shield at collar of air shaft (Jeffrey).



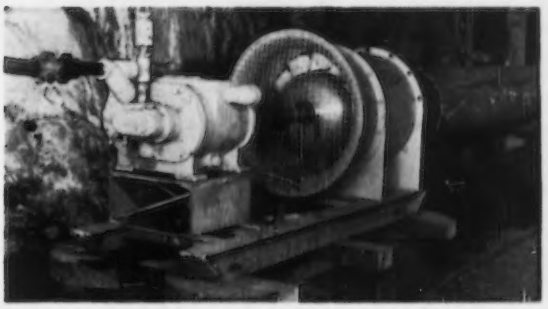
UNIQUE ventilation system at International Nickel Co.'s Frood-Strobie mine in Ontario, Canada. Surface fan blows fresh air over large open stopes to main intake. Ice is made in winter by spraying water at top of stopes, and latent heat of freezing is transferred to air. In summer air is cooled over ice and water is drained to pumping system. Axial-flow fan is one of the world's largest. Diameter is 198 in., and the 12 adjustable blades are rotated by 650-hp motor. Capacity is 750,000 cfm.



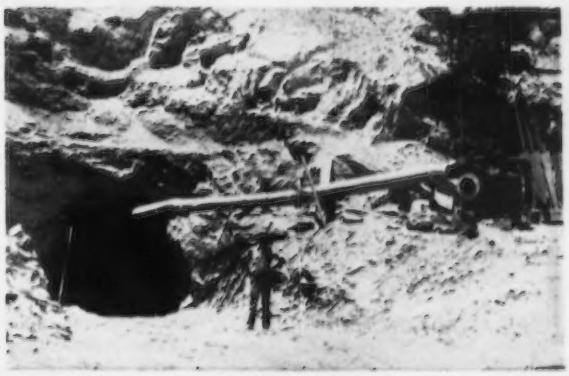
LARGE belt-driven Aerodyne fan installed underground at a large iron mine in Michigan.

TUBEAXIAL fan in main pipe conduit boosts air to production and development artas at Mi Vida mine near Moab, Utah.

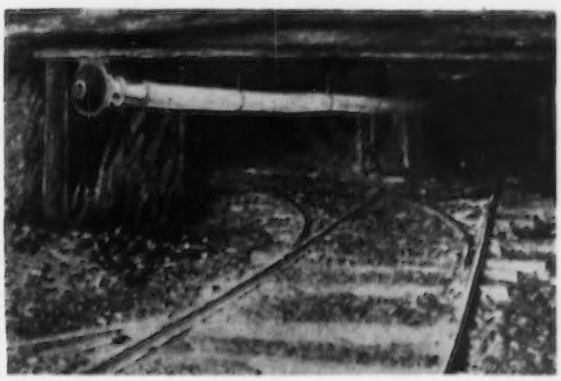
LARGE AERODYNE exhaust fan is installed at the collar of air shaft at a lead-zinc mine in New Mexico.



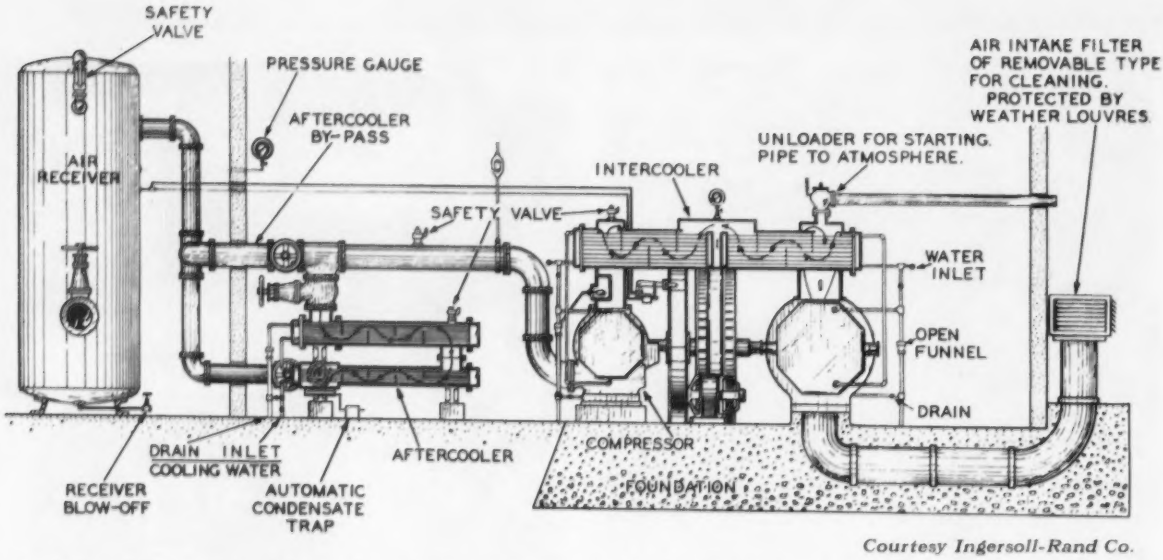
NOVEL fan installation in drift of a nickel mine in Canada. Fan is an air-driven Axivane portable unit mounted on a 4-wheel car truck.



PORTABLE centrifugal fan driven by a gasoline engine supplies air to underground workings at Jackpile uranium mine in New Mexico.



TYPICAL electric-driven Vano fan installed in main drift to supply extra air to headings.



Courtesy Ingersoll-Rand Co.

MODEL INSTALLATION of a horizontal double-acting two-stage compressor complete with safety and control units, water cooling and pipe systems, air intake filter, after cooler, water separator traps and air receiver (*I-R*).

What's Available in Air Compressors

AFTER ELECTRIC CURRENT, the power source most widely used in mining is compressed air. It is employed to operate an ever increasing array of mining equipment, from drills, loaders, locomotives to hoists, bin chutes, mine doors, etc., to actuate control units, for agitation, conveying materials, pneumatic flotation machines, and smelting furnaces and converters.

Six basic types of compressors available to industry and their operating principles can be seen and studied in check chart opposite. To find the answer to which compressor type to choose you must look into such factors as discharge pressure required, capacity needed, power supply characteristics, availability and cost of cooling water, space needed for compressor, type of control desired, compressor weight, type and size of foundation and amount of maintenance expected.

Reciprocating. Most of the compressors in use at mining enterprises, large or small, are of this type, though some of special rotary design have entered the field in recent years. They are designed to produce air at pressures ranging from 90 to 125 psi for powering diverse underground and surface equipment. In looking over the following panorama of air compressors we see reciprocating designs such as horizontal, vertical or V double-acting single-stage units, either water or air cooled, and double-acting two-stage units of horizontal, vertical, M, V, Y, semi-radial or right angle types, all water cooled. Stationary compressors, installed singly or in multiple units in central air plants, find use at large and long-life enterprises. Where temporary work is to be done in extensive workings, it will be found advantageous to select portable or semi-portable compressors with consequent elimination of laying and maintaining long lines.

Rotaries of the two-lobe type with capacities up to 5,000 cfm at 50 psi, centrifugals from 500 to 150,000 cfm (multistage units can compress air to 150 psi) at 35 psi, and axial-flow compressors up to 100,000 cfm at pressures from less than 1 psi to several psi (multistage axials can compress air to 150 psi or more) find their principal use in concentrators equipped with pneumatic flotation machines and in smelters. A rotating vane-type portable unit is finding increased acceptance in open pits and quarries and for auxiliary plant work. Some of the advantages offered by the types mentioned are: no valves, no reciprocating parts such as pistons, no rod bearings, no vibration, low oil consumption, and others.

TABLE 1. Effect of Intake Temperature On Capacity

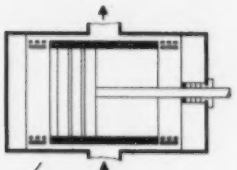
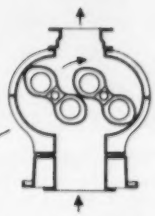
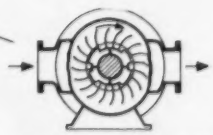
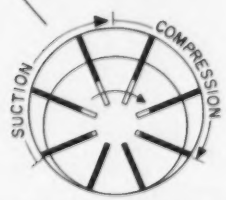
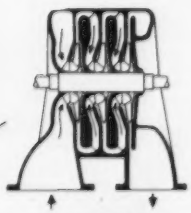
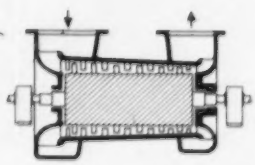
Intake temp, F	Intake required cu ft	Hp saved per cent
30	925	7.5
40	943	5.7
50	962	3.8
60	981	1.9
70	1,000	0.0
80	1,019	−1.9
90	1,038	−3.8
100	1,057	−5.7
110	1,076	−7.6
120	1,095	−9.5

Drives. Choice of drive is a matter of economics involving fuel cost, availability, cost of electricity, chance of electrical outages, availability of steam, and others. Most of the stationary-type compressors are driven by electric motors, either direct connected or by belt, though some are powered by steam, gas or diesel engines. Portables in general are driven by gasoline or diesel engines, and in some instances where electric power connection is near, by electric motor.

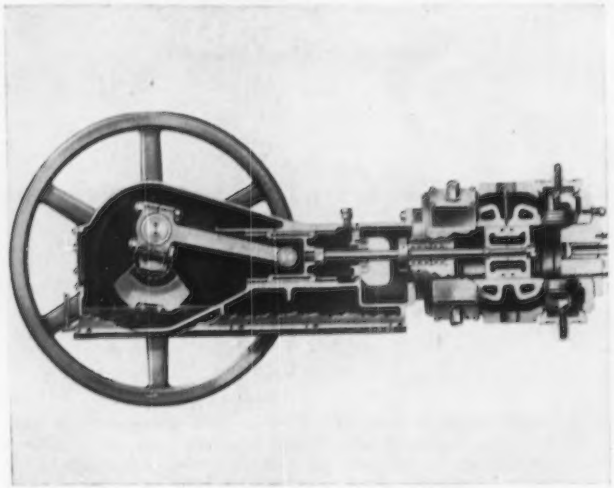
Accessories. These include intercoolers, aftercoolers, control units which usually come as part of the compressor. Others like separators, silencers, traps, receivers, intake filters, etc. are supplied separately. Proper design of the pipe system and installation of the units mentioned at designated points are most important if clean, dry air at specified pressure is to reach the equipment to be driven.

Plant site. Be sure to select site close to point where air is used. Place air intake at coolest spot available, far away from smoke stacks or general dust and dirt conditions. Power required to compress air varies with the incoming temperature above or below 70 deg F. For actual values see Table 1.

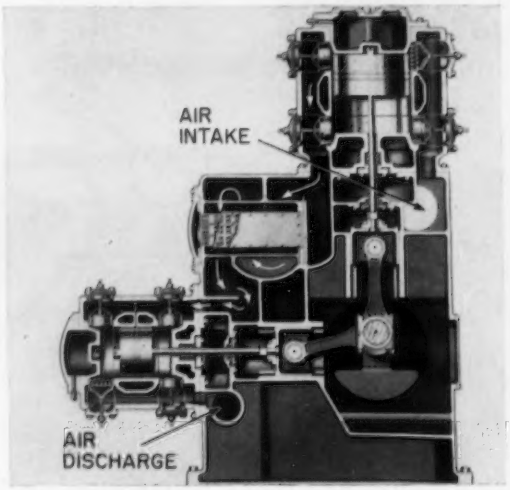
Here Is How The Six Basic Types of Modern Compressors Operate

Class	Type	Operating Characteristics
POSITIVE DISPLACEMENT	 RECIPROCATING	**AIR IS SUCKED** into cylinders through valves during the suction stroke. At end of discharge stroke, air leaves at higher pressure. Separate valves are provided for inlet and outlet.
	 TWO-LOBE ROTARY	**IDENTICAL** impellers are held in fixed relationship to each other by external gears. During rotation, each impeller traps air between its outer surface and the casing. Discharge of air begins when upper impeller tip passes to edge of casing. Bottom tip of impeller pushes enclosed air into discharge piping, compressing it against the backpressure.
	 LIQUID-PISTON ROTARY	**MULTIBLADE** rotor revolves in an elliptical casing partly filled with liquid, usually water. When revolving, the rotor carries liquid around with it, the blades forming a series of buckets. With liquid following casing contours, it alternately leaves and returns to the space between the blades (twice each revolution). As liquid leaves bucket, air is drawn in. When liquid returns, it compresses air to discharge pressure.
	 SLIDING-VANE ROTARY	**AIR IS TRAPPED** between vanes as rotor passes inlet opening. As rotor turns toward discharge port, volume of cell between any two vanes decreases, causing air pressure to rise to rated discharge value. Vanes sliding in and out of slots as rotor turns are held against casing by centrifugal force.
DYNAMIC	 CENTRIFUGAL	**AIR TAKEN IN** at impeller eye, is accelerated radially. Some static pressure rise occurs in the impeller, but most is in diffuser section of casing, where velocity converts to static pressure.
	 AXIAL-FLOW	**AIR IS ACCELERATED** in a direction generally parallel to the shaft. Unit resembles a turbine, with each pair of moving and stationary blade-rows forming a stage. Pressure rise per stage is relatively small.

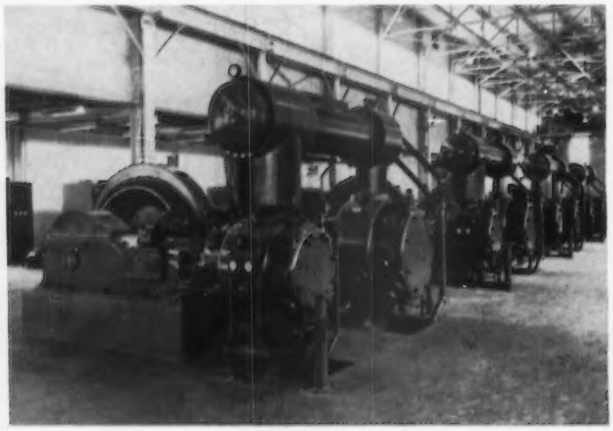
Individual illustrations courtesy Power



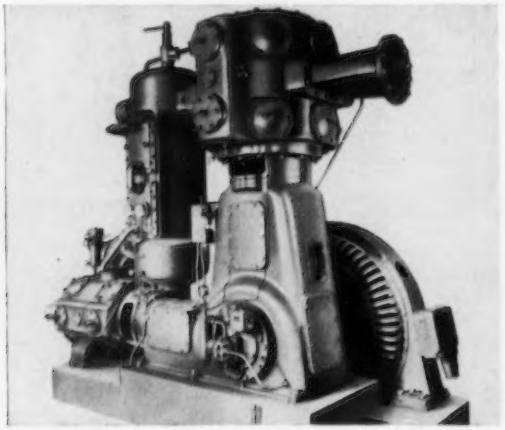
HORIZONTAL SINGLE-FRAME double-acting single-stage units like these are built in wide range of capacities. Normal pressure rating is given as 100 psi (*Worthington*).



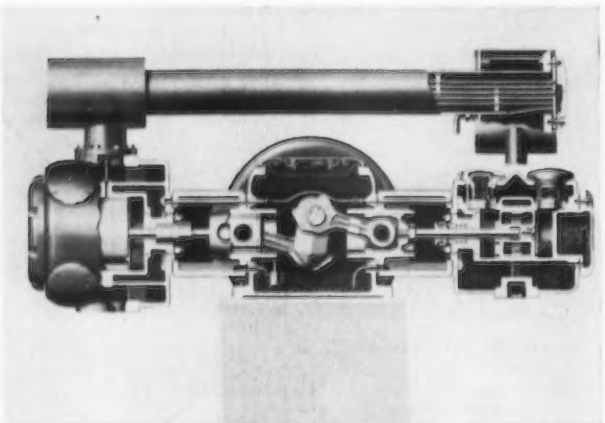
PACKAGE-TYPE compressor has its cylinders at right angles, takes little space. Direct driven by synchronous motor, 125 to 350 hp, is water cooled, two-stage (*I-R*).



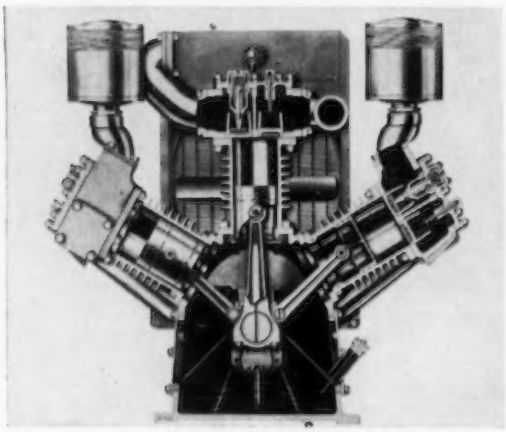
CAPACITY OF THE UNITS in this neat central compressor plant at large mine is 4,704 cfm each. All are driven by 800-hp motors (*C P*).



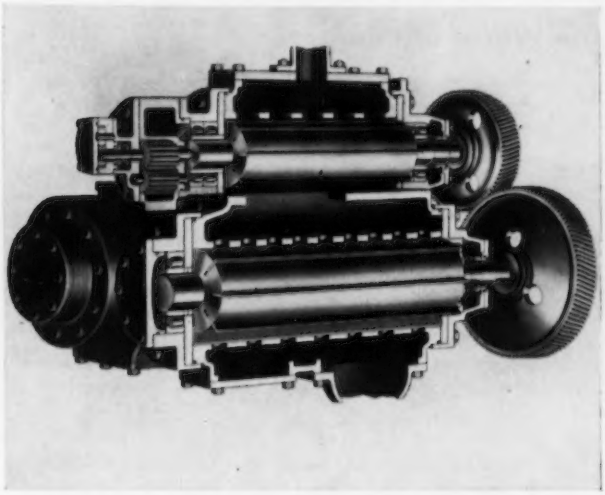
ANOTHER L-TYPE compressor of 1,865-cfm capacity, water cooled, is driven by flywheel-type synchronous motor. Little space is required (*Atlas Copco*).



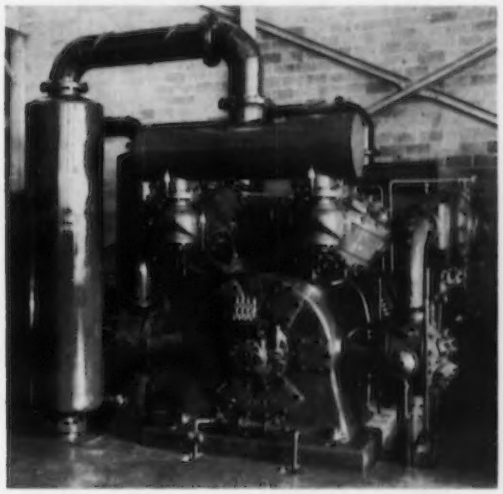
OPPOSED-CYLINDER, heavy-duty compressor employs two-stage compression, with tube-type intercooler between high and low pressure cylinders. Built-in reduction motors range from 75 to 100 hp. Flat-top foundation of 65½ cu ft accommodates compressor (*I-R*).



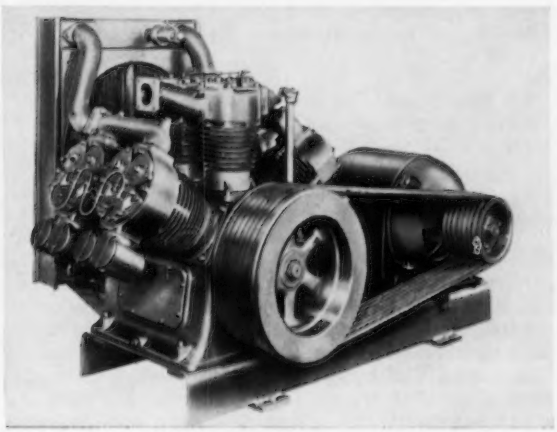
"M" TYPE COMPRESSOR: capacities range from 140 to 538 cfm at 100 to 125 psi, hp 25 to 100, air cooled. Compact design requires small floor space. Units are available up to 40 hp (*Worthington*).



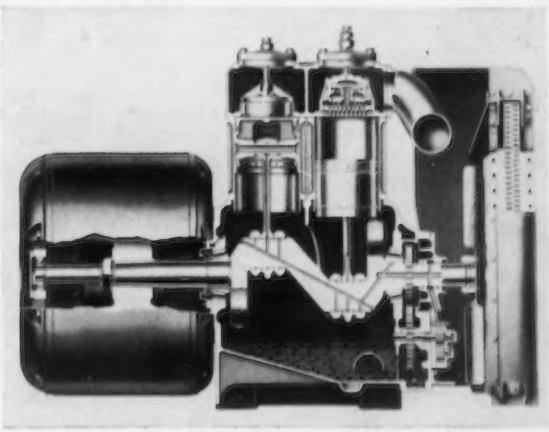
TWO-STAGE GYRO-FLOW type rotary portable compressor has a capacity of 900 cfm (*I-R*).



SIX-CYLINDER, SEMI-RADIAL type, stationary compressor has piston displacement of 100-hp unit, 550 cfm. Air cooled and belt driven, it requires small space (*Joy*).

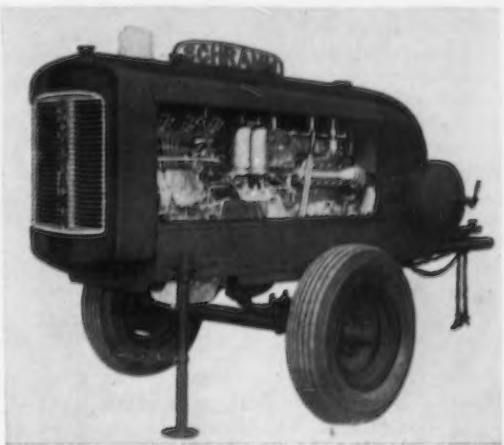


FOUR-CYLINDER HEAVY-DUTY compressor of semi-radial design is water cooled, with double acting, dual-cushion valves. Capacities range from 1,186 to 3,896 cfm (*Le Roi*).



THREE-CYLINDER MOTOR compressor employs two-stage, air cooled compression. Piston displacement is 686 cfm. Floor space required is 22 sq ft (*I-R*).

ALL ROTARY PORTABLE compressor capable of delivering 600 cfm at 100 psi is water cooled, diesel driven. Weight is 8,700 lb (*G-D*).



TRAILER-MOUNTED, unistage 125-cfm 4-cylinder unit is water cooled, gasoline or diesel driven (*Schramm*).

Fig. I. A Quick Guide to the World of Pumps

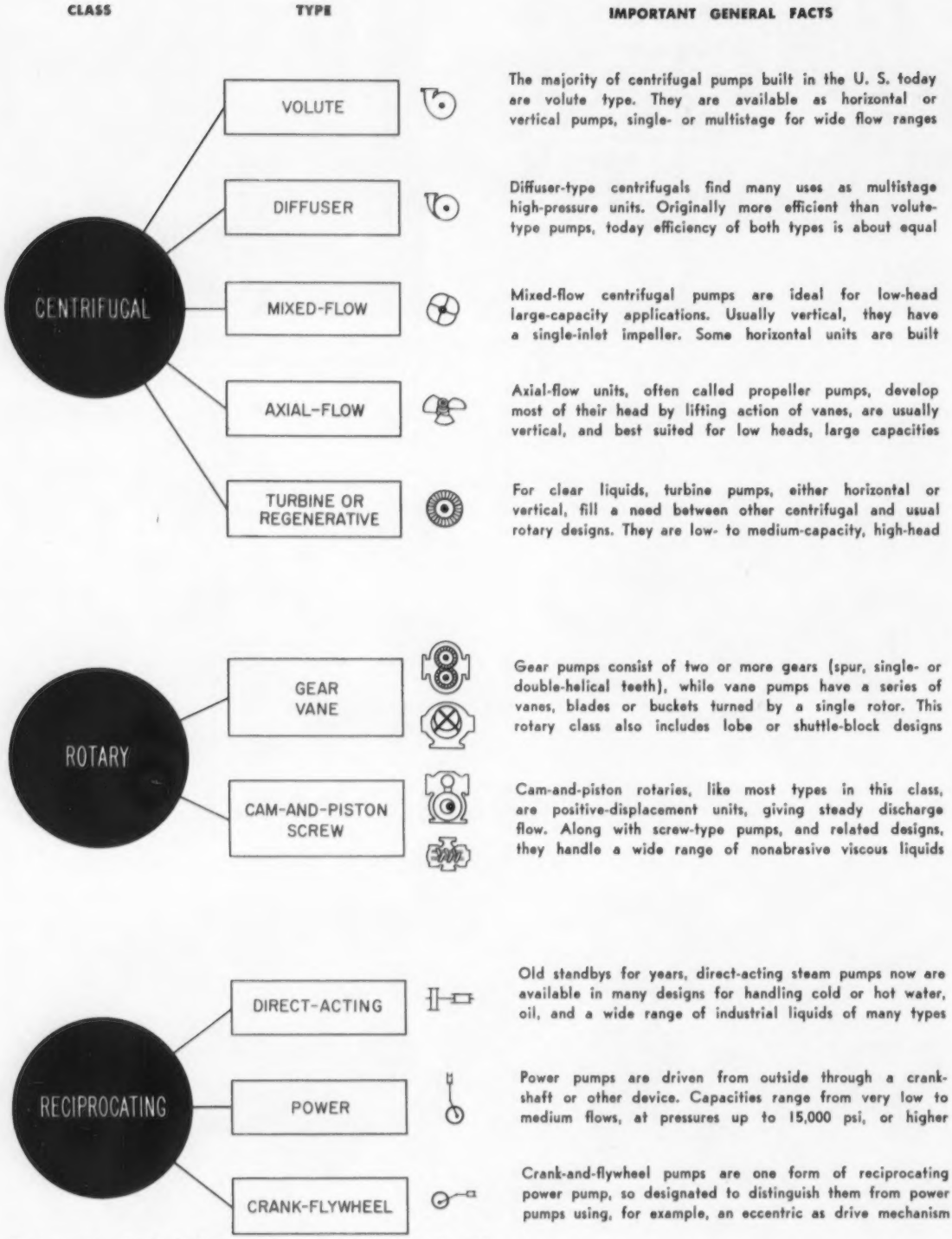
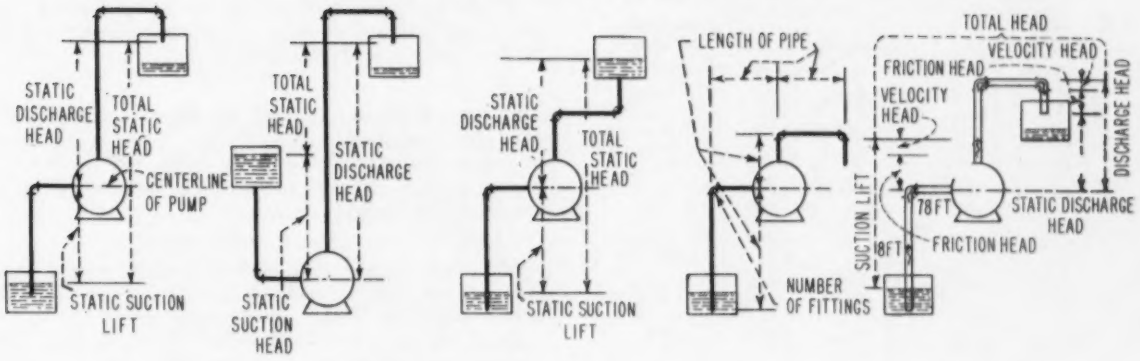

CLASS
TYPE
IMPORTANT GENERAL FACTS
CENTRIFUGAL
VOLUTE
The majority of centrifugal pumps built in the U. S. today are volute type. They are available as horizontal or vertical pumps, single- or multistage for wide flow ranges
DIFFUSER
Diffuser-type centrifugals find many uses as multistage high-pressure units. Originally more efficient than volute-type pumps, today efficiency of both types is about equal
MIXED-FLOW
Mixed-flow centrifugal pumps are ideal for low-head large-capacity applications. Usually vertical, they have a single-inlet impeller. Some horizontal units are built
AXIAL-FLOW
Axial-flow units, often called propeller pumps, develop most of their head by lifting action of vanes, are usually vertical, and best suited for low heads, large capacities
TURBINE OR REGENERATIVE
For clear liquids, turbine pumps, either horizontal or vertical, fill a need between other centrifugal and usual rotary designs. They are low- to medium-capacity, high-head
ROTARY
GEAR
VANE
Gear pumps consist of two or more gears (spur, single- or double-helical teeth), while vane pumps have a series of vanes, blades or buckets turned by a single rotor. This rotary class also includes lobe or shuttle-block designs
CAM-AND-PISTON
SCREW
Cam-and-piston rotaries, like most types in this class, are positive-displacement units, giving steady discharge flow. Along with screw-type pumps, and related designs, they handle a wide range of nonabrasive viscous liquids
RECIPROCATING
DIRECT-ACTING
Old standbys for years, direct-acting steam pumps now are available in many designs for handling cold or hot water, oil, and a wide range of industrial liquids of many types
POWER
Power pumps are driven from outside through a crankshaft or other device. Capacities range from very low to medium flows, at pressures up to 15,000 psi, or higher
CRANK-FLYWHEEL
Crank-and-flywheel pumps are one form of reciprocating power pump, so designated to distinguish them from power pumps using, for example, an eccentric as drive mechanism

Chart courtesy W. B. Stephenson, Allen-Sherman-Hoff Pump Co. and Power, a McGraw-Hill publication.

Typical Piping Hookups for Pumps



Modern Pumps, Their Design, Applications and Selection

PUMP SELECTION is becoming more specialized and more important. This is especially true in the metallurgical branch of the mining industry since the advent of new processes for chemical refining of metals, recovery of uranium oxide, and others. Many factors are involved in the performance of pumping equipment, and they should all be considered in the selection of pumps for mines and reduction plants. To help the mining and metallurgical engineer make the best selection, here is a handy and definite classification of all types of pumps.

Basic Types

In general, there are three basic types of pumps—reciprocating and rotary, both of which are positive displacement pumps, and centrifugal in which water passage is never closed. Diaphragm pumps of various designs belong to the first category. Each classification is further sub-divided into a number of types as shown in Fig. 1. For example, under the reciprocating classification we have direct-acting, power and crank-wheel type pumps. Rotary units include gear, lobe, screw, sliding vane, swinging vane, cam, cam and piston, shuttle-block, radial piston, axial piston and rubber tube "squeegee" designs. Under centrifugal pumps we find volute, diffuser, mixed-flow, axial-flow, and turbine or regenerative units.

Here are a few operating characteristics and applications covering the three pump types:

Reciprocating

1. Direct acting pump. Flow pattern tries to conform to the pumping system. It has high head and low capacity compared to the centrifugal.

2. Power pump. Unit has a definite flow pattern determined by crank or eccentric design, connecting rod length and number of cylinders and is used for any heads up to the highest, and relatively low capacities. Flow pattern can be smoothed out by use of air cushion chamber.

3. Diaphragm pump. Flow pattern depends on the drive. If air, steam, or hydraulic, it will conform to the system. If the drive is a mechanical piston, with or without oil cushion, the flow pattern will be definite. It is used for moderate heads, and low capacities.

Typical applications of direct-acting and power pumps include drilling slush, deep well, flooding, gathering and pipe lines, mine dewatering, water supply, filter press feed, boiler feed, hydraulic presses, volatile liquids, viscous liquids and general service. Diaphragm pumps can handle miscellaneous corrosive, toxic, abrasive or expensive materials, where packing leakage cannot be tolerated, or packing would not stand up.

Rotary

Design is based on the principle of positive displacement, with seal between suction and discharge formed by close running clearances or sliding or rolling contact. Operating characteristics are:

1. Flow is proportional to speed, except for losses due to slip (internal leakage from discharge to suction), and suction conditions.

2. Flow is theoretically independent of pressure differential. Actual capacity is affected by increase in slip with pressure.

3. Power varies directly with pressure and speed.

4. Power at constant speed and pressure varies with viscosity.

5. Self-priming. Rotary pumps are good vapor handlers, consequently self-priming. Most types should never be operated dry because the liquid is necessary for sealing and lubricating the close clearances. A few types will handle dry gas.

Applications include handling clean, non-abrasive, non-corrosive liquids in general; wide range of viscosities, from solvents to heavy tars, etc.; low viscosity, volatile fluids, including entrained gas or vapor; for pressures up to 1,000 psi on non-lubricants; for higher pressures on lubricating fluids; for very low flows over wide range of pressure; and metering.

(Continued on next page)

Table 1. Pipe Friction Loss for Water

(Wrought-iron or steel Schedule 40 pipe in good condition)

Dia, in.	Flow, gpm	Velocity, ft per sec	Velocity head, ft of water	Friction loss, ft of water per 100 ft pipe
2	50	4.78	0.355	4.67
2	100	9.56	1.42	17.4
2	150	14.3	3.20	38.0
2	200	19.1	5.68	66.3
2	300	28.7	12.8	146
4	200	5.04	0.395	2.27
4	300	7.56	0.888	4.89
4	500	12.6	2.47	13.0
4	1000	25.2	9.87	50.2
4	2000	50.4	39.5	196
6	200	2.22	0.0767	0.299
6	500	5.55	0.479	1.66
6	1000	11.1	1.92	6.17
6	2000	22.2	7.67	23.8
6	4000	44.4	30.7	93.1
8	500	3.21	0.160	0.424
8	1000	6.41	0.639	1.56
8	2000	12.8	2.56	5.86
8	4000	25.7	10.2	22.6
8	8000	51.3	40.9	88.6
10	1000	3.93	0.240	0.497
10	3000	11.8	2.16	4.00
10	5000	19.6	5.99	10.8
10	7500	29.5	13.5	24.0
10	10,000	39.3	24.0	42.2
12	2000	5.73	0.511	0.776
12	5000	14.3	3.19	4.47
12	10,000	28.7	12.8	17.4
12	15,000	43.0	28.7	38.4
12	20,000	57.3	51.1	68.1

Table 2. Resistance of Fittings and Valves

(Length of straight pipe, ft, giving equivalent resistance)

Pipe size, in.	Std ell	Med-rad ell	Long-rad ell	45-deg ell	Tee	Gate valve, open	Globe valve, open	Swing check, open
1	2.7	2.3	1.7	1.3	5.8	0.6	27	6.7
2	5.5	4.6	3.5	2.5	11.0	1.2	57	13
3	8.1	6.8	5.1	3.8	17.0	1.7	85	20
4	11.0	9.1	7.0	5.0	22	2.3	110	27
5	14.0	12.0	8.9	6.1	27	2.9	140	33
6	16.0	14.0	11.0	7.7	33	3.5	160	40
8	21	18.0	14.0	10.0	43	4.5	220	53
10	26	22	17.0	13.0	56	5.7	290	67
12	32	26	20.0	15.0	66	6.7	340	80
14	36	31	23	17.0	76	8.0	390	93
16	42	35	27	19.0	87	9.0	430	107
18	46	40	30	21	100	10.2	500	120
20	52	43	34	23	110	12.0	560	134
24	63	53	40	28	140	14.0	680	160
36	94	79	60	43	200	20.0	1000	240

Centrifugal

The centrifugal pump is the most widely used in U. S. industry (about 85% diaphragm 10%, reciprocating and others 5%). Operating characteristics are:

1. Capacity varies directly, the head as the square, and the horsepower as the cube of either the speed or diameter of the impeller, the other being constant.

2. Delivers any capacity from zero to maximum at constant speed along its curve.

3. Head, power and efficiency all are functions of capacity.

4. Flow adjusts itself automatically to head fluctuations.

5. The head, and therefore the power, is definitely limited, consequently the pump is safe from over-pressure, and the drive is safe from overload.

6. Not self-priming in itself, the centrifugal pump will handle only small proportion of vapor before losing prime or vapor binding, but can be made self-priming by suction priming chamber and discharge air separator, and special volute design.

Applications include pumping water, chemicals, oil, etc., flooding, fire, mine dewatering, water supply, pulp, sand, gravel and others. Heads are normally up to 200 ft per stage. Capacities are virtually unlimited. Higher heads per stage are practical at very high capacities.

Range of sizes in which pumps are built is wide. Capacities vary from a few milliliters per hour required for some laboratory pumps to the 750,000-gpm units at Grand Coulee Dam. Some of the small rotary gear pumps used in aircraft weigh but a few ounces and consume as low as 1/250 hp, while the Grand Coulee pump, with impeller alone weighing 30 tons, requires 65,000 hp. The inlet and outlet connections in these pumps vary from ⅛-in. standard pipe size to 14 ft at Grand Coulee.

Materials for pumps. Principal factors affecting choice of materials for construction of pumps include suspended-solids abrasiveness, corrosion resistance, electrochemical action, liquid temperature, head per stage, discharge pressure, structural considerations and pump load-factor. Materials include all common machinable metals and alloys, such as gray cast iron, carbon steel, tool steels, chrome steel, chrome-nickel steels, nickel and high-nickel alloys, aluminum, magnesium, titanium metal, tin bronzes, aluminum bronzes, lead, zinc alloys and others. Some pumps are made of special alloys so hard that they can be machined only by grinding, such as high-silicon irons.

Drives for pumps. Most pumps in operation today are driven by electric motors, though steam, gas and hydraulic turbines, gasoline, gas and diesel engines are also used. Factors affecting drive choice include pump and driver rpm, service conditions, pump characteristics, availability and cost of power and physical details of the installation. Driver speed may be limited to a certain band, as in gas and diesel engines. This band may be above or below ideal pump speed for job conditions. A speed increaser or decreaser is warranted where pump runs continuously. On standby units, cost and complication of a speed changer can be saved by selection of a compromise pump design.

Most electric motors used for pump drive in the U. S. are full-voltage-starting ac units, though some dc motors find application. Motor designs include the squirrel-cage type used in most instances, and synchronous and wound-rotor motors. Recent developments in canned and axial-air-gap sealed motors are almost certain to have a major influence in design of future small pumps. With some canned motors, straight-through flow is obtained which simplifies piping connections. Axial-air-gap motors shrink to almost pancake thickness, allowing easy installation and care. Both types are leakproof, important in many process jobs.

Starting torque. In general practice it is found that normal-starting-torque motors are entirely adequate for starting centrifugals, even with discharge valve open. Starting torque from rest seldom exceeds 15 to 20% of normal operating torque. It is usually highest in a sleeve-bearing pump that has long been idle.

Overloading an electric motor is possible if pump horsepower increases with a change in capacity. This is not so with a steam turbine, because of the fixed throttle position; turbine speed is always such that pump torque equals turbine torque. Internal-combustion engines may be rated for continuous load at rated speed, or for load at wide-open throttle, or for both. Most engines rated on continuous load will carry an overload. It is well to study pump characteristics before driving engine for the installation is selected.

Where varying capacity, head, or both is needed, variable-speed operation of centrifugals may offer advantages. Since pump operating is fixed by crossing of its H-Q curve with system-head curve, only way to alter operating conditions of a constant-speed unit is to change system by throttling. In many instances it is more practical and economical to vary pump speed. An economic study is usually needed to decide between variable and constant speed for given service. Power saving of variable speed may be more than offset by higher cost to be written off over unit's life.

Automatic controls on pumps are not new. There are two classes—namely, the simple "on-off" control, and control that makes the pump respond to certain conditions. The only problem is the selection and adaption of equipment properly designed to do the job.

Selecting a Pump

Principal decisions affecting selection of a pump are size, type and best buy. Where unusual or difficult liquid conditions prevail the task is more complex. The five steps outlined below have proved helpful for typical general-purpose, process and similar applications.

1. Sketch layout. Base sketch on actual job as planned. Show all piping, fittings, valves, equipment, etc. Mark length of pipe runs of sketch. Be sure and include all vertical lifts (see sketch p 63).

2. Determine capacity. Many factors enter into the capacity of a pump. Data on water systems are available. Weir boxes, trajectory measurements, chip tests and die tests can help estimate water flow in open launders and closed pipe systems.

3. Figure total head. Sketch (p 63) shows various heads in typical pumping systems. Tables 1 and 2 will help in calculating the heads, and it is well to have pump manufacturer check them.

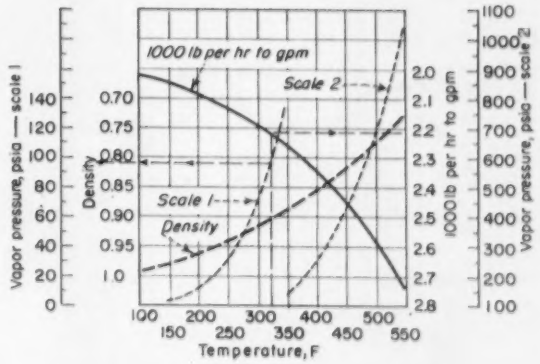
4. Study liquid conditions. This is important, for liquid heavier than water (specific gravity greater than 1) takes more horsepower to be moved from one point to another; lighter liquids require less power. Liquid temperature and vapor pressure fix the net positive suction head needed for satisfactory operation. Here again it is advisable to have the manufacturer check suction conditions.

Table 3. Typical Centrifugal-Pump Rating Table

Size	Gpm	Total head, ft: 10	15	20	25	30
2C	100			1000-.8	1060-1.0	1150-1.2
	150			1070-1.2	1150-1.5	1240-1.7
	200				1290-2.1	1360-2.4
3CS	150	750-.53	850-.78	950-1	1030-1.2	1100-1.5
	200		950-1.1	1010-1.4	1100-1.7	1170-2
	250			1170-1.9	1190-2.3	1260-2.6
	300					1400-3.5
3CL	200	690-.63	800-.95	910-1.3	1010-1.6	1110-2.05
	300	870-1.2	950-1.6	1000-1.9	1100-2.4	1170-2.8
	400			1200-3.1	1230-3.7	1290-4.1
	500					1490-5.8
4C	400	750-1.3	850-1.8	940-2.4	1040-3	1120-3.7
	600			1080-4	1170-4.6	1210-5.5
	800					1400-8.4
1½D	25		617-.21	707-.03	778-.40	845-.51
	50		680-.37	760-.49	865-.63	900-.76
	75			856-.78	916-.94	980-1.1
	100					
	125					
	150					
2DL	150		820-.93	850-1.1	930-1.35	990-1.6
	200			970-1.8	1040-2.1	1080-2.3
	250					
	300					

Example: 1080-4 indicates pump speed is 1080 rpm, actual input required to operate pump is 4 hp.

Table 4. Aids in Planning a Piping System

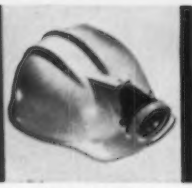


THESE CURVES show vapor pressure of water at different temperatures, and give conversion factors for flow

5. Choose class and type. Reviewing the liquid characteristics furnishes another clue to class because exceptionally severe conditions may rule out one or another right at start. Sound economics dictates choosing the pump that provides the lowest cost per gallon pumped over the useful life of the unit. Operating factors that should be taken into account when deciding on class include type of service (continuous or intermittent), running speed preference (high-speed pumps often cost less), future load expected and its effect on pump heads, possibility of parallel or service hookup, and many others, peculiar to a given job. These factors deserve as much study as head and capacity. Once you know class and type you are ready to check these in Table 3 which lists pump capacity, head, horsepower, etc. In the matter of large custom-built units, the pump manufacturer performs most of the steps listed, basing his design on information supplied by the engineer on the job.

Water - resistant wool-lined winter liner for safety hat (*Parker*)

Miner's cool cap (*Mine Safety Appliances*)



Laminated plastic miner's skullguard (*Mine Safety Appliances*)

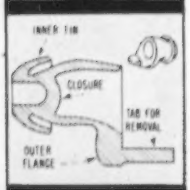
Fiberglass miner's safety cap (*Bullard*)

Polister resin miner's safety cap (*Bullard*)

Wool winter liner for safety hat (*Parker*)

How to Safeguard Your Miners

Phenolic hat with protector shield (*Willson*)



Ear stopper (*Mine Safety Appliances*)

Lee sonic ear-valve

First aid kit—pocket packet (*Bullard*)

Unit first aid kit (*Mine Safety Appliances*)

All-purpose work gloves (*Mine Safety Appliances*)

Skullguard eye-shield (*Mine Safety Appliances*)

Visor goggles (*Mine Safety Appliances*)

Panoram goggles (*Mine Safety Appliances*)

Contour - spec goggles (*Willson*)

Mono mask respirator (*Willson*)

Self-rescuer (*Mine Safety Appliances*)

Rubber protection suit (*Mine Safety Appliances*)

Car dropper's belt (*Mine Safety Appliances*)

Rubber and leather safety boots (*Goodrich-Thom McAn—Mine Safety Appliances*)

Battery Carrying Belts (*Mine Safety Appliances*)

Powder bag (*A.B.C.*) (*American Brattice Cloth Corp.*)

Furnace man safety hood (*Mine Safety Appliances*)

Plastiglas-headgard (*Davis*)

Fiber glass safety hat (*Bullard*)

Phenolic safety hat

Dust hood (*Willson*)

How to Safeguard Mill and Smelter Workers

Tab-type winter hat lining (*Mine Safety Appliances*)

Dustfoe ultra-filter respirator (*Mine Safety Appliances*)

Interchangeable respirator (*Willson*)

Flex-A-Foam dust mask (*Flexo Products, Inc.*)

First aid pocket kit (*Davis*)

Unit pack safety first kit (*Bullard*)

Melter's goggles (*Mine Safety Appliances*)

Mono goggles (*Willson*)

Cup goggles (*Willson*)

SMR ear stopper (*Surgical Mechanical Research*)

Ear cushions (*Mine Safety Appliances*)

Safety belts
Leather (*Mine Safety Appliances*)

Cotton (*Bullard*)

Swing-back face shield (*Bullard*)

Rubber gloves (*Charleston Rubber*)

Safety boots—leather (*Thom-McAn—Mine Safety Appliances*)

Gloves — leather-asbestos (*Mine Safety Appliances*)

Chemklos coveralls (*Mine Safety Appliances*)

Explosives and Their Applications

Maker and Type	Strength	Where Best Used	1¼ x 8-in. Ctgs. per 50-lb Case
AMERICAN CYANAMID CO.			
Nitroglycerin dynamite	20 to 60%	Ditching by propagation. Submarine work. High water resistance	103 to 108
Ammonia dynamite	20 to 60%	Quarrying. Construction. Medium water resistance	100 to 107
Amex	80% to 100% blasting gelatin	Quarrying. Construction. Mining other than coal. Fair water resistance. Fumes: good	120 to 170
Straight gelatin	20 to 100%	Quarrying. Oil and gas wells. High water resistance. Fumes: very poor	89 to 100
Standard gelatin	30 to 90%	Quarrying and open pit operations. General underground mining, including shaft and tunnel work. Excellent water resistance. Fumes: good	91 to 99
Semi gelatin	80% to 100% blasting gelatin	Quarrying and open pit operations. General underground mining, including shaft and tunnel work. Good water resistance. Fumes: good	110 to 137
Cyamon blasting agent	40-50-60%	Quarrying. Stripping. Construction. Insensitive to caps or Primacord. Non-headache producing	Sticks not less than 3-in. dia
Cyamite blasting agent	65%	Quarrying. Stripping. Construction. Insensitive to caps or Primacord. Non-headache producing	Sticks not less than 4½-in. dia
Cya-Gel-Pak	40%	Mud capping. Chute blasting. Construction. Packed in Polyethylene bag. Can be formed into any shape	Bag packed
APACHE POWDER CO.			
Nitroglycerin dynamite	15 to 60%	Ditching. Work requiring high shattering effect. Water resistance poor to good. Fumes: fair to poor	104 to 110
Standard dynamite	15 to 60%	Open or underground work under dry conditions. Water resistance fair. Fumes: good	108 to 110
Special dynamite	20 to 55%	Open or underground work under dry conditions. Mining soft materials. Water resistance fair to poor. Fumes: good	172 to 115
Gelatin	25 to 100%	Open or underground work where great water resistance is necessary or in extremely hard rock. Water resistance very good. Fumes: good in 25 to 60% class. Poor in 75 to 100% class	87 to 106
Special gelatin	30 to 90%	Open or underground work under severe water conditions or in hard rock. Water resistance very good. Fumes: good in 30 to 80% class. Fair in 90% class	90 to 106
Amogel	30 to 60%	General open or underground work where moderate water conditions prevail. Water resistance good. Fumes: good	140 to 110
Quarry dynamite	5 to 70%	Open dry work in large holes where bulk-packed, free-flowing dynamite can be used, such as in open pit mining. Water resistance poor. Fumes: poor	Bag packed
Carbamite blasting agent	70%	Open work in dry holes 5-in. plus, such as open pit mining for relatively soft material. Requires high explosive primer. Water resistance poor. Fumes: poor	Bulk packed
ATLAS POWDER CO.			
Nitroglycerin dynamite	20 to 60%	Ditch blasting and other open work. Water resistance fair. Fumes: fair to poor	105 to 115
Extra dynamite	15 to 60%	May be used underground where ventilation is good. Limited water resistqnce. Fumes: fair	105 to 115
Blasting gelatin	100%	For very hard rock and under high heads of water. Very good water resistance. Fumes: fair to poor	100 to 110
Gelatin	20 to 100%	For extreme wet work and hard, tight shooting. Very good water resistance. Fumes: good to poor	85 to 110
Giant gelatin	30 to 90%	Used underground where ventilation is good. Very good water resistance. Fumes: good to poor	85 to 110

Maker and Type	Strength	Where Best Used	1¼ x 8-in. Ctgs. per 50-lb Case
Gelodyn	65%	General underground work. High cartridge count offers attractive economies. Good water resistance. Fumes: good	110 to 125
Amodyns	65%	Stoping and tunneling. Slab and angle blasting in limestone mines. Limited water resistance. Fumes: good to fair	118 to 182
Apcodyn	65%	Pre-waxed shells used underground and redipped shells for surface work. Limited water resistance. Fumes: good to fair	128 to 153
Apex	20 to 70%	A quarry and stripping explosive. Good water resistance. Fumes: poor	Large ctgs
Flo-Dyn, Canyon Bag	10 to 70%	For vertical drill holes in quarry and open pit and Coyote tunnel work. Limited water resistance. Fumes: fair to poor	Bag packed
Amocore	65%	Quarry and stripping work. Ammonium nitrate base with Gelatin core, assured detonation any length column without additional primers. Fumes: poor	Large ctgs
Amocol	65%	Blasting agent. Nitro carbo nitrate. Supplied in heavy paper shells and bags. Fumes: poor	Large ctgs
Chemex	70%	Specially formulated ammonium nitrate to provide maximum moisture resistance and free flowing properties. Fumes: poor	Large bags 50 lb and 100 lb
Atlas Granules	65%	Fertilizer grade ammonium nitrate. Economical. For dry holes. Bulk delivery. Fumes: poor	Large bags 80 lb
E. I. DU PONT			
Straight dynamite	20 to 60%	Ditch blasting by propagation. Water resistance poor in lower strengths. Very good in higher strengths	102 to 106
Red Cross Extra dynamite	20 to 60%	Quarry and open pit operations and general agricultural and excavation work where material is of medium hardness. Fair water resistance in small diameter; good in large. Fumes: good in small diameter, poor in large	110
Du Pont Extra dynamite	A to H (High velocity series) A-1 to G-1 (Low velocity series)	Both products used for soft ores and non-metallic minerals underground and in the open. Grades A, B, C, D, E, A-1 and B-1 have fair water resistance. Other grades poor. Fumes: good to fair	115 to 172
Red Cross blasting FR dynamite	25 to 65%	Coyote tunnel blasting and loading small holes, either sprung or not sprung. Water resistance very poor. Fumes: poor	Bag packed
Du Pont gelatin	20 to 90%	Open pit and underground blasting in very hard material. Water resistance very good. Fumes: good in 20 to 50% grades. Very poor in higher grades	85 to 107
Blasting gelatin	100%	Deep well shooting and cutting steel. Waterproof. Fumes: poor	83
Hi-Velocity gelatin	40 to 90%	Seismograph and submarine work, mud capping and dobey shooting in both underground and quarry and open pit operations. Water resistance very good. Fumes: very good in lower grades, very poor in 70 to 90% grades	94 to 120
Special gelatin	25 to 90%	Underground work and quarry and open pit operations. Water resistance very good. Fumes: very good in 25 to 80% grades. Fair in 90% grade	89 to 109
Gelex	No 1 to 5	Underground work and open work of all types. Have replaced gelatin of about same bulk strength. Give lower costs than gelatin dynamites when applicable. Water resistance good. Fumes: good	110 to 150
Nitramon blasting agent	A, B and No. 2	Quarrying, stripping and open pit operations. Coyote tunnel blasting. Water resistance unlimited. Non-headache producing	Packed in sealed metal containers
Nitramon blasting agent	S	2-in. and 2½-in. diameters. Seismograph and submarine work. Water resistance unlimited. Non-headache producing	Packed in sealed metal containers with threaded ends
Nitramex blasting agent	No. 2	Tough shooting or hard formations where breaking bottom presents a problem. Water resistance unlimited. Very high loading density. Non-headache producing	Packed in sealed metal containers

(*Continued on next page*)

EXPLOSIVES APPLICATIONS

Maker and Type	Strength	Where Best Used	1¼ x 8-in. Ctgs. per 50-lb Case
Nitramex blasting agent....	No. 3	2½-, 3- and 3½-in. diameters. Same as Nitramex No. 2. Water resistance good. Non-headache producing	Packed in sealed containers
Nitramite blasting agent...	.....	Excellent blasting action in both hard and soft materials and either vertical or horizontal holes. Good water resistance. Non-headache producing	Sealed containers
Nitramite FR blasting agent	.....	Coyote shooting or for pouring in holes down to 3-in. diameter. Non-headache producing	Bag packed
Pelletol.....	No. 1	Waterproof, free-running explosive for pouring around packaged explosives and blasting agents to obtain maximum loading density. Non-headache producing	Bulk packed
Akremite blasting agent*... *Licensed exclusively to Du Pont under Maumee Collieries Co. Process Patent No. 2,703,-528. Sublicensed to other companies	.....	Overburden and wide variety of bank shooting. Dry holes. Packing moisture resistant. Non-headache producing	Bag packed
HERCULES POWDER CO.			
Nitroglycerin dynamite....	25 to 60%	Ditch blasting by propagation. Mudcapping. Water resistance good in higher grades. Fumes: very poor	104 to 110
Extra dynamite.....	40 to 60%	Quarry and open pit mining. Clay blasting. Water resistance good. Fumes: poor	108 to 110
Hercomite® 2 to 7 inclusive	65%	Underground mining and quarry operations. Water resistance fair. Fumes: fair	120 to 175
Gelatin.....	20 to 90%	For use where water conditions are severe or concentrated loads are required. Fumes: good to poor	87 to 110
Blasting gelatin.....	100%	Submarine blasting and shooting oil, gas, or water wells where there is high water pressure. Fumes: poor	110
Gelatine extra.....	30 to 90%	General underground work. Quarry and open pit mining. Water resistance very good. Fumes: good	90 to 106
High-pressure gelatin.....	40 to 90%	Submarine blasting and shooting oil, gas, or water wells where there is high water pressure. Fumes: poor	94 to 108
Gelamite 1, 2 and 3.....	65%	General underground work and quarry and open pit mining. More water resistant than Hercomite. Fumes: very good	112 to 132
Herculite bag powders.....	22 to 60%	Quarry and open pit mining. Water resistance very poor. Fumes: poor	Large diameter cartridges only
Hercomite bag.....	65%	Quarry and open pit mining where powerful, yet slow, heaving action is desired. Water resistance very poor. Fumes: poor	Bag packed
Hercomite bag-X	65%	Quarrying, especially in quarry tunnel blasting. Water resistance very poor. Fumes: poor	Bag packed
Tritex.....	65%	Stripping, open pit, and general quarry work	Large-diameter cartridges only
ILLINOIS POWDER MFG. CO.			
Nitroglycerin dynamite....	15 to 60%	Ditching by propagation. Mudcapping. Water resistance good in higher grades. Fumes: very poor	100 to 110
Ammonia dynamite.....	15 to 60%	Quarry work, secondary shooting, clay mining, and ditching. Less water resistance than nitroglycerin. Fumes: poor	104 to 110
Nitroglycerin gelatin.....	20 to 100%	Submarine and demolition work. Road construction, etc. Water resistance excellent. Fumes: poor	85 to 105
Ammonia gelatin.....	20 to 80%	Underground quarrying and mining operations. Work in hard rock. Tunnel driving. Water resistance good. Fumes: good	90 to 108
Semi-gelatin.....	6 Ajax series 60 to 65%	Underground metal mining and quarrying to tunnel driving where medium loading density and moderate water resistance is required. Fumes: good	105 to 133
Powertols.....	B, C, D, E, F and G 65%	Blasting moderately hard rock. Underground operations such as salt, iron, clay, sand, bauxite mining. Quarrying and construction work	120 to 175
	H 65%	For blasting softer rock	220
	4 and 5 65%	For soft, stratified rock or consolidated soil. All Powertols have fair water resistance. Fumes: good	142 to 153

Maker and Type	Strength	Where Best Used	1¼ x 8-in. Ctgs. per 50-lb Case
Bag powders	10 to 65%	Open pit, stripping, and quarry operations. Water resistance and fumes very poor	Bag packed
Blasting agent A	65%	Quarrying, stripping and open pit operations. Coyote tunnel blasting. Both require a high explosives primer. Water resistance unlimited. Non-headache producing	Ctgs 4-in. and larger
Blasting agent B	50%		
Gomex	....	Overburden and wide variety of bank shooting. Dry holes. Moisture resistant packing. Non-headache producing	Bag packed
Dolomites	65%	Non-metallic mines and underground quarries. Rock work and tunnels. Water resistance fair. Fumes: good to fair	128 to 153
Blasting gelatin	100%	Demolition work. Well shooting. Water resistance excellent. Fumes: fair to poor	100 to 110
Straight nitroglycerin gelatin	20 to 100%	Demolition work. Well shooting. Submarine work. Water resistance very good. Fumes: good to poor	85 to 100
Standard ammonia gelatin	30 to 90%	Quarries. Tunnels. Metal mines. Water resistance very good. Fumes: good to poor	85 to 110
Tungites (semi-gelatins)	65%	Interchangeable with straight and standard type gelatins where less water is encountered. Tunnel work of all types. Water resistance good. Fumes: good	110 to 125
OLIN-MATHIESON CHEMICAL CORP.			
Free flowing dynamite	20 to 65%	Poor water resistance. Poor fume classification. Has heavy heaving action rather than shattering action	135 to 140
Mine-Gel (semi gelatin)	65%	Good to fair water resistance. Very good fume classification. Good ventilation needed underground. Economical for quarrying and open pit work	100 to 150
Nitroglycerin dynamite	15 to 60%	Powerful quick-acting high explosive. Not recommended for underground work. Water resistance is fair	
N. G. gelatin dynamite	20 to 100%	Extremely water resistant. Low fume formation. Good for underground. Strongest commercial dynamite	102 to 106
Super dynamite, Series 1 and 2	65%	Poor water resistance. Wide range in stick count; gives them high or low velocity as required. Very good fume classification. Used for soft ore	115 to 170
Super dynamite, Series 3 and 4	65%	Fair water resistance. Same as above	115 to 170
Special ammonia gelatin	30 to 90%	Excellent water resistance. Excellent fume classification. Grades of 30 to 70% good for underground. Recommended for open-pit work	92 to 100
Special (ammonia) dynamite	15 to 60%	More economical grade than nitroglycerin dynamites. As a class do not have good water resistance. May be used underground where ventilation is adequate. Well adapted to open-pit mining	106 to 108
TROJAN POWDER CO.			
"Standard" explosives	20 to 70%	Open pit and underground work. Excellent for mudcapping in secondary blasting. Water resistance good. Fumes: very good	109 to 120
"C" explosives	30C, 40C, 50C, 60C, and 70C	General blasting in open pit or underground workings, especially where heaving and stressing action is required. Water resistance fair, improving as strengths increase. Fumes: very good	116 to 122
Low density explosives	Medium to low velocity varying with density. All grades have excellent gas volumes	Economical and effective explosives for softer rock or where good heaving rather than great shattering effect is required. Underground mining or non-metallic minerals and open pit strip mining. For upper charges in deep, large-diameter holes and for secondary block-hole work. Water resistance fair. Fumes: very good	
TL 509			130
TL 502			135
TL 503			145
Trojatol No. 2		Not recommended for underground use	155
Trojamite 2 to 7			125 to 169
Bag powders	10 and 20% CC Bag 25 to 60% C Bag 60% C Special Bag Trojamite Bag	Quarry, highway, and construction work. Coyote tunnels. Sprung sinker or wagon drill holes and ragged large diameter holes	Bag packed

List of Open Pit Blasthole Drills

	TYPE	MOUNT	POWER	MODEL	MANUFACTURER	CAPACITY FT	HOLE DIA IN.
1	**Hammer (3-in. bore)**	Tricycle wagon	Air	G-150	Chicago-Pneu.	25	2½
2	**Hammer (4-in. bore)**	Tricycle wagon	Air	G-400	Chicago-Penu.	30	3
3	**Hammer (4-in. bore)**	Self-propelled crawler	Air	G-800 Tracdrill	Chicago-Pneumatic	50 (sect. steel)	3
4	**Hammer**	Tricycle	Air	DR-40	LeRoi	24	2¾
5	**Hammer**	Tractor w/int. compressor	Air (Gasoline)	T-286 Mobildril	LeRoi	12	2
6	**Hammer**	Tractor	Air (Gaso. or Diesel)	T-286 Twin Drill	LeRoi	24	2¾
7	**Hammer (4-in. bore)**	As desired	Air	DH99J	Gardner-Denver	to 100 —125	to 3
8	**Hammer (4½-in. bore)**	As desired	Air	DH123J	Gardner-Denver	to 150	to 3½
9	**Hammer (5½-in. bore)**	As desired	Air	DH143	Gardner-Denver	to 100	to 4½
10	**Hammer**	Cwlr or wheels	Air	Challenger	Joy Mfg.	50	3½–4½
11	**Hammer**	Self-prop. cwlr	Air	Crawl-Ir	Ingersoll-Rand	50	2¾–3½
12	**Down-the-hole percussion**	Self-propelled crawler	Air (Diesel or Electric)	Drillmaster (DM2-DHD325)	Ingersoll Rand	125	6 and 6½
13	**Down-the-hole Percussion**	Self-propelled crawler	Air (Diesel or Electric)	Quarrymaster (QM3-DHD400)	Ingersoll Rand	120	7
14	**Down-the-hole Percussion**	Truck, crawler or trailer	Air	150	Reich Bros.	300	4
15	**Roller Cone, Drag, or Diamond**	Skid, Truck or Trailer	—	Drill Scout	Gustafson Mfg.	650	3 (2⅛-in. core)
16	**Roller Cone, Drag or Diamond**	Self-propelled	Gasoline	P-350	Houston Tool	350	4½
17	**Roller Cone, Drag or Diamond**	Crawler, Skid Trailer or Truck	Gasoline or Diesel	400	Reich Bros.	1500	6 (6-in. core)
18	**Roller Cone, Drag or Diamond**	Crawler, trlr. or truck	Diesel	600	Reich Bros.	2500	9 (8-in. core)
19	**Roller Cone or Drag**	Truck, Crawler or Tractor	Diesel	650	Reich Bros.	2500	9
20	**Roller Cone**	Crawler	Diesel or Electric	750	Reich Bros.	3000	12
21	**Roller Cone or Drag**	Truck	Gasoline	C B H	George E. Failing	400	4¼ to 6¼
22	**Roller Cone or Drag**	Crawler	Air (Diesel or Electric)	Quarrymaster (QM3-QRD)	Ingersoll Rand	Practical Hole Depths	6¾ to 7¾
23	**Roller Cone**	Crawler	Air	Drillmaster (DM2-RD)	Ingersoll-Rand	Practical Hole Depths	6¼
24	**Rotary**	Crawler	Diesel	40-R	Bucyrus-Erie	—	6¾–9
25	**Rotary**	Crawler	Electric	50-R	Bucyrus-Erie	—	9⅞–12¼
26	**Roller Cone**	Truck	Gasoline	225 Blastair	Joy Mfg.	500	6¼ max.
27	**Roller Cone**	Crawler	Diesel or Electric	56-BH Middle-wt Champion	Joy Mfg.	125	6¼
28	**Roller Cone**	Crawler	Diesel or Electric	58-BH Heavy-wt Champion	Joy Mfg.	250	6¾ to 7⅞
29	**Roller Cone**	Crawler	Diesel or Electric	58-BHR Heavy-wt Champion	Joy Mfg.	200	6¾ to 9
30	**Roller Cone**	Crawler	Diesel or Electric	60-BH Super Hvywt. Champ.	Joy Mfg.	200	9 to 12¼
31	**Roller Cone**	Truck	Gas or Diesel	6TA Truck	Winter Weiss	1500	7⅞ max.
32	**Roller Cone**	D-6 Cat	Diesel	6TA Tractor	Winter Weiss	400	9 max.
33	**Roller Cone**	LHC RF192 Truck	Gasoline or Diesel	Schramm 76 Truck Mounted Roto-drill	Schramm	700 (with 4½-in. pipe)	6¼
34	**Roller Cone**	Schramm Heavy Model 125 CFH Pneumatractor	Gasoline	Schramm 75 Rota-drill on Pneu-matractor	Schramm	500 (with 2⅞-in. pipe)	4¼
35	**Roller Cone**	Truck or Trailer	Gasoline or Diesel	KF40	Stardrill-Keystone	2000 (5-in., 2⅝-in. pipe)	5 (2-in. core)
36	**Drag (Horiz. Auger) or Roller Cone**	Truck	Gas., Diesel or Electric	103-T.M. Horizontal	Salem Tool	150–200	to 12
37	**Drag (Horiz. Auger) or Roller Cone**	Self-propelled	Gas., Diesel or Electric	103-S.P. Horizontal	Salem Tool	15–200	to 12
38	**Drag (Vert. Auger) or Roller Cone**	Flat vehicle bed	Gas., Diesel or Electric	106-8 Vertical	Salem Tool	150	6
39	**Drag (Vert. Auger) or Roller Cone**	Flat vehicle bed	Gas., Diesel or Electric	106-24 Vertical	Salem Tool	6-in., 150; 24-in., 25 to 30	to 24
40	**Drag (Auger)**	Tracdril, truck or tractor	Air	CP-556 Rotauger	Chicago-Pneumatic	50	3
41	**Roller Cone or Churn Combination**	Truck	Gasoline or Diesel	42 Duodrill	Sanderson-Cyclone	1000	6 (3-in. core)
42	**Churn**	Crawler	Electric, Gas., or Diesel	22-T	Bucyrus-Erie	—	5⅝—6⅝
43	**Churn**	Crawler	Electric, Gas., or Diesel	27-T	Bucyrus-Erie	—	6—6⅝
44	**Churn**	Crawler	Electric, Gas., or Diesel	29-T	Bucyrus-Erie	—	9
45	**Churn**	Crawler	Electric or Diesel	50-T	Bucyrus-Erie	—	9—12

And Specifications Aids Selection

	TRANSMISSION	TYPE FEED	FEED FT	TYPE HOIST	DERRICK FT PULL	BIT RPM	WEIGHT LB	COST $
1	—	Chain	6	—	—	—	760	—
2	—	Chain	10	—	—	—	1,800	—
3	—	Chain	12	—	—	—	5,000	—
4	—	Air motor	Option	—	—	—	1,500	3,935
5	—	Air motor powered	6, 8 or 10	—	—	—	4,400	6,145
6	—	Air motor powered	Cust. option	—	—	—	5,650	10,500
7	—	Chain-air motor driven	8, 10 or 12	—	—	—	Drill, 138; plus feeds, 650-750	Drill, 1,210; feeds, 1,420-1,580
8	—	Chain-air motor driven	8, 10 or 12	—	—	—	Drill, 154; feeds, 650-750	Drill, 2,325; feeds as above
9	—	Chain-air motor driven	12	—	—	—	Drill, 385; feed 2,500	Drill, 4,800; feed, 14,300
10	—	Chain	24½	—	—	—	11,000	—
11	—	Chain-air motor	10	Air motor	10	200	6,000	—
12	—	Air motor powered chain	25	Air motor	25	Variable 45-75	34,000	—
13	—	Air motor powered chain	40	Air motor	40	Variable 45 to 75	72,000	—
14	—	Air	10	Air	10	35	5,000	9,000
15	Direct, chain drive	Hydraulic	5½	Hydraulic	5	to 200	1,200	2,250
16	Four Speed	Chain and cable	15	Two Drum	—	0 to 600	—	—
17	Infinitely variable	Hydraulic	12	Hydraulic	12	0-200	10,000	12,000
18	Infinitely variable	Hydraulic	12	Hydraulic	12	0-120	20,000	24,000
19	Infinitely variable	Hydraulic	30	Hydraulic	30	0-120	25,000	29,000
20	Infinitely variable	Hydraulic	60	Hydraulic	60	0-120	65,000	75,000
21	3 speeds and 1 reverse	Chain	—	—	31½	—	13,500	—
22	—	Air-motor chain pull down	40	Air Motor	40	45-75	72,000	—
23	—	Air-motor chain pull down	25	Air Motor	25	Variable 45-75	34,000	—
24	—	—	—	—	—	—	89,000 (Elect.)	—
25	—	—	—	—	—	—	123,500 (Elect.)	—
26	3 speeds for., 1 rev.	Hydraulic with Auto. Chuck	3	Drum	—	110, 181, 311 (R272)	15,000 (Less Truck)	—
27	4 speeds and 1 reverse	Hydraulic with Auto. Chuck	2½	Drum	40	25 to 110	35,000	45,000
28	4 speeds and 1 reverse	Hydraulic with Auto. Chuck	4	Drum	45	15 to 75	55,000	60,000
29	4 speeds and 1 reverse	Hydraulic with Auto. Chuck	4	Drum	40	25 to 115	60,000	69,000
30	5 speeds and 1 reverse	Hydraulic with Auto. Chuck	5	Drum	50	10 to 160	100,000	95,000
31	3 speed	Chain	—	Double Drum	Various	50-250	30,000	—
32	—	Chain	—	Double Drum	Various	70 to 100	42,500	—
33	5 speed and 2A 45 Fuller Aux.	Hydraulic	25	Air Driven Drum	20½	Standard 64; also 48-172	41,500—Gasoline; 44,100-Diesel	Std. Model 25,800
34	5 speed	Hydraulic	12 & 17	None; Rapid Travel hydraulic	15	Standard 75; also 28-148	16,500	Std. Model 12,365
35	Chain	Chain	20	Drum	29 also 32½	38 to 175	38,000	29,200
36	Four speed and reverse	Hydraulic	8	—	—	Variable	3,400	4,890
37	Four speed and reverse	Hydraulic	8	—	—	Variable	4,000	5,590 with gas. power
38	Four speed and reverse	Hydraulic	8	—	8	Variable	6,000	7,900
39	Four speed and reverse	Hydraulic	8	—	8	Variable	7,000	9,980 with gas. power
40	—	Chain	16	—	—	225 and 500	5,000 on G-800 Trac.	—
41	3 speed and reverse	Hydraulic	10	Hydraulic and Winch	20	100 to 350	15,000	14,500
42	—	—	—	—	—	—	14,000 (Elect.)	—
43	—	—	—	—	—	—	23,600 (Elect.)	—
44	—	—	—	—	—	—	27,000 (Elect.)	—
45	—	—	—	—	—	—	60,400 (Elect.)	—

How to Systematize Selection

BOTH SURFACE AND UNDERGROUND muck handling equipment can be selected using the same basic factors. About the only differences are that underground there is general prohibition of gasoline fueled engines and there are ventilation requirements for diesels. Of course, on the surface a portion of overburden is often finer sized and the limits on working clearances are less critical.

Tables systematize selection from the great variety of units available. We have prepared a single table which covers the basic selection factors for all muck handling equipment. We prepared it as a questionnaire to manufacturers. It is explained below.

Most of the entries can be taken from specification sheets. But some are not readily available and must be secured by personal inquiry. The table admittedly has limitations but it can be used as is for preliminary study or it can be amended and enlarged as the user desires.

The tables have many possible uses. For example, assuming a desired output has been established, the number of working units required with various equipment can be determined using line 5. Underground, size of opening may restrict possible choices by reference to line 8. In open pit using rail haul, distance from toe of face to center of track may restrict choice by reference to lines 9a3 and 9b2.

On the following pages are examples of completed forms as submitted by several manufacturers—to whom *E& MJ* expresses considerable thanks. One caution: the forms have been edited only to a very limited extent and interpretation of explanation may not have been precise or the same by all manufacturers.

Type of equipment which this table can cover is not restricted to the examples. All units shown in *E&MJ's* "Panoramas" Mid-June 1956 Mining Guidebook, can be handled.

Explanation of Table

All lines do not apply to all units, refer to notes below which are keyed by number to lines on table.

Use dash in space if not applicable, "na" if not available and "x" if omitted. Express fractions as decimals, e.g. not ⅛ but 0.125.

Use This Table

1	Classification of unit		
2	Mount		
3a	Power: hp		
b	type		
4a	Capacity: volume (in cu yd)		
b	weight (in tons)		
5a	Productive output (in tons per hr)		
b	At transport distance (in ft)		
6a	Initial cost (in $)		
b	Additional per 100-ft haul (in $)		
c	Operating cost ($ per ton per 100 ft haul)		
d	Operating crew (number of men)		
7a	Working wt. empty (in tons)		
b	Additional per 100-ft haul (in tons)		
8a	Working clearances, minimum H/W/L (in ft)	/	/
b	Auxiliary clearance, minimum WxHxL (in ft)	×	×
9	Working ranges		
a	Loading:		
	(1) Size opening WxH or WxL (in ft)	×	
	(2) Forward reach, Max./Min. (in ft)	/	
	(3) Side reach, max./min. (in ft)	/	
	(4) Depth reach, max./min. (in ft)	/	
	(5) Height (in ft)		
b	Dumping:		
	(1) Size opening WxH or WxL (in ft)	×	
	(2) Horizontal reach max./min. (in ft)	/	
	(3) Height, max. (in ft)		
	(4) Angle of discharge (in deg)		
	(5) Direction of discharge		
	(6) Type		
10	Working power applied by		
11	Working controls		
12	Traveling clearances WxHxL (in ft)	×	×
13	Traveling speed: empty: for./rev. (in ft per min)	/	
	loaded: for./rev. (in ft per min)	/	
14	Grade negotiable, max, loaded/empty (in %)	/	
15	Turning radius, min (in ft)		
16	Ground pressure, empty/loaded (in lb per sq in.)	/	
17a	Moving size largest component WxHxL (in ft)	×	×
b	Moving weight largest component (in tons)		
18	Special remarks		

1. Classification of Unit—as desired. (See Buyers' Guide and "Panoramas" in 1956 Guidebook.)

2. Mount—Classifications: Crawler, Stationary Foundation, Floating Hull, Rail, Skid, Walking Shoe, or Wheel; plus, if applicable, Self-Propelled, Pushed or Towed.

3. Power

a. HP—Main operating engine or motor, net output at fly wheel (or equivalent shaft) at rated (governed) RPM at sea level at 60° F.

b. Type—Classifications: Air (pneumatic), Diesel, Diesel-electric, Electric battery, Electric cable, Electric trolley, Gas (combustion), Gasoline, Hydraulic, Steam or Non-Powered.

4. Capacity

a. Volume (in cu yd)—On level, struck volume of container, approximate volume moved by blade-type component or approx. carrying volume per foot of conveyor length (see 5a (2). below). For blades, show formula used to calculate in "Special Remarks" (line 18) or use $0.8\ WH^2$. For conveyors, show formula or use $0.03\ W^2$. (Note: W and H in yds).

b. Weight (in tons)—Maximum lift, carry, push or pull under optimum actual working conditions, through full function of machine but not necessarily through entire working range. Bucket or other container is considered part of machine. Note: It applies to the muck handling function of machine, not the pull of a tractive type component (such as the tractor of a tractor shovel) unless the muckhandling function is based on this (such as bulldozer or slusher hoist). For self-propelled vehicles, maximum working drawbar-pull is usually considered as limited to 90% of total weight for crawler units and to 65% of weight on tread of driving wheels of wheeled units.

5a. Productive Output (in tons per hr)

(1) An approximate destimate under average practical working conditions with standard rated container entered in 4a. Assume no waiting (idle) time, delays or maintenance or repairs.

(2) Based on handling average blasted rock or gravel, defined as having lumps up to about 18-in. cubes and weighing about 1.75 tons per cu yd in loose condition (Rock of Sp.G. 2.75 with 1/3 voids). If equipment can only handle finer material add "F" after entry.

b. At Transport Distance (in ft)— Approximate practical (or recommended) transport distance, one way (i. e. load to dump).

Of Muck Handling Equipment

6. a. **Initial Cost** (in $)—Approximate new, f.o.b. manufacturer's plant, as described on line 7 a
   b. **Additional per 100 ft haul** (in $)—As described on line 7 b
   c. **Operating Cost** ($ per ton per 100 ft haul)—Rough estimate for U. S. not including labor, depreciation or amortization; handling material as indicated in 5 a. (2) above. For loading type equipment, ignore 100 ft haul specification. Include maintenance and repairs.
   d. **Operating Crew** (number of men)—direct operating and helpers if needed.

7. a. **Working Wt. Empty** (in tons)—Complete empty unit (shipping weight less packaging). Including all essential components except that portion which may be varied in length to fit haul (does not include any railroad trackage).
   b. **Additional per 100 ft haul** (in tons)—Approximate weight of additional components for extending haul 100 ft assuming minimum height of supports, straight level haul on firm smooth surface (including railroad trackage, trolley wire, etc.).

8. a. **Working Clearances, Minimum H/W/L** (in ft)—Smallest overall space required for complete function of machine, i. e. all operations through loading, carrying and dumping, at ground or other most advantageous level (also see line 12). Assuming 90° swing or equivalent for loaders, except these which are especially designed for rear or side dump. For trucks, assuming no back up and turn while loading or dumping (also see line 15). For conveyors and slushers, covers only muck moving component. Does not include separate dumping mechanisms for railroads, certain trailers, etc., nor driving mechanisms of slushers, conveyors, etc. (see line 8b.). H=height, L=Length in direction of axis of travel and W=width.
   b. **Auxiliary Clearance, Minimum WxHxL** (in ft)—Over-all space required for essential separate driving or dumping mechanisms such as slusher hoist, rotary or other car or other vehicle dumping mechanisms. But does not cover special devices such as belt conveyor trippers, et al. Includes clearance of muck carrier.

9. **Working Ranges**—Under actual practical working conditions with standard equipment. Note: If any entry is based on longer or larger component than used for 8a, add "L" after entry.
   a. **Loading**
      (1) **Size Opening WxH or L** (in ft)—Clear inlet opening of container or dimension of blade or width of belt as given in 4a.
      (2) **Forward Reach, Max./Min.** (in ft)—Distance of cutting edge or teeth of loader (at most advantageous elevation of container) while lifting rated quantity (see line 4a.), measured horizontally along longitudinal centerline of operating unit from axis of horizontal rotation (swing or turn), axis of scraper-slusher drum, or center of gravity of mount. Assume no movement of mount itself. For dragline or clamshell crane this includes a bucket throw equal to 1/3 maximum dumping height.
      (3) **Side Reach, max./min.** (in ft)—Distance of outside cutting edge at maximum possible angle or swing to side, measured horizontally at right angles from longitudinal centerline of operating unit.
      (4) **Depth Reach, max./min.** (in ft)—Distance of cutting edge of loader below elevation of plane of contact between mount and support (i.e. ground level in most cases).
      (5) **Height** (in ft)—For loaders maximum reach of cutting edge above plane in 9a. (4). For transporters, height of lip or edge of muck carrying component above plane in 9a. (4).
   b. **Dumping**
      (1) **Size Opening WxHxL** (in ft)—Clear outlet
      (2) **Horizontal Reach, max./min.** (in ft)—Distance of dumping lip from same point as in 9a. (2), assume no casting effect.
      (3) **Height, max.** (in ft)—Distance of dumping lip in highest dumping position from same plane as in 9a. (4)
      (4) **Angle of Discharge** (in deg.)—Inclination of bottom surface of container in highest (full) dump position
      (5) **Direction of Discharge**—Bottom, Side, Front or Rear
      (6) **Type of Discharge**—Tilt, Drop, Ejector Blade or Conveyor and through Jaws (or Doors), if applicable.

10. **Working Power Applied By**—Gravity, Cable (Rope), Gears or Piston Rod (Hydraulic or Air) for main operation of loading or dumping.

11. **Working Controls**—Direct Mechanical or power assist by Air, Hydraulic or Electric (including Electronic and Magnetic) apparatus.

12. **Traveling Clearances WxHxL** (in ft)—For mobile units, completely assembled unit in working condition as in 8a but with containers, booms, etc., placed in most compact position without disassembly. L indicates length along axis of travel. For conveyors, dragline scraper-slushers and similar units, this entry only covers the overall dimensions of the driving mechanism or largest single component (not including erectable structural members) for moving purposes.

13. **Traveling Speed: Empty, For./Rev.** (in ft per min); **Loaded, For./Rev.** (in ft per min)—Maximum on level. Load is rated volume in 4 (a) above. For conveyors, slushers and similar units, this entry covers working speeds of belt or rope, etc. For excavator-loaders it covers moving speed. Note: 10 mph = 880 ft per min.

14. **Grade Negotiable, max., Loaded/Empty** (in %)—Load is rated volume (4a. above) of material indicated in 5a. (2). For mobile units, climbing a hard, dry surface.

15. **Turning Radius, min.** (in ft)—Of outside edge. Equipment in normal position while moving forward with full rated load as indicated in 4a. above. If any wheel, crawler etc., must be fully braked or held idle to accomplish this, add "B" after entry. Do not show data which might be accomplished by reversing any part of running gear unless so designed, if so, mark "R".

16. **Ground Pressure, Empty/Loaded** (in lb per sq in.)—Standard shoe and equipment. Load is rated volume in 4 a. of material indicated in 5 a. (2).

17. a. **Moving Size Largest Component WxHxL** (in ft)—largest single component into which unit can be disassembled by operating company mechanic.
    b. **Moving Weight Largest Component** (in tons)—as above.

18. **Special Remarks**—Give model number, any outstanding main engine, power train or other mechanical specifications, any limitations or especially advantageous applications, any auxiliary attachments available, etc.

	Classification of Unit	Slusher Hoist 2 Drum Axial	Slusher Hoist 3 Drum Axial	Slusher Hoist 2 Drum Axial	Bulldozer Straight	Bulldozer Straight	Bulldozer U BLADE ONLY	Bulldozer Straight	Bulldozer Straight
	Model	ASNN-OH	30NNN-3D	75NM-41D	No. 9	No. 8	No. 8	No. 7	No. 6
	Manufacturer	Ingersoll-Rand	Ingersoll-Rand	Ingersoll-Rand	Caterpillar	Caterpillar	Caterpillar	Caterpillar	Caterpillar
2	Mount	S	S	S	P	P	P	P	P
3a	Power: HP	5	30	75	—	—	—	—	—
b	Type	A	E	E	N	N	N	N	N
4a	Capacity: Vol. (in cu yd)	0.33	1.00	2.8	9.9	6.86	8.9	4.42	3.04
b	Wt. (in tons)	0.53	1.75	4.0	24.35	17.55	17.55	11.7	7.65
5c	Productive Output (in tons per hr)	25	100	240	438	222	289	184	146
b	At Transport Distance (in ft)	100	200	200	300	300	300	300	300
6a	Initial Cost (in $)	na	na	na	3,620	2,400	2,720	1,970	1,795
b	Additional per 100 ft haul (in $)	—	—	—	—	—	—	—	—
c	Operating Cost ($ per ton per 100 ft haul)	0.02	0.02	0.02	.002	.001	.0015	.0016	.0015
7a	Working Wt. Empty (in tons)	0.20	1.5	3.0	5	3.5	3.5	2.2	1.75
b	Additional per 100 ft haul (in tons)	—	—	—	—	—	—	—	—
8a	Working Clearances, min. H/W/L (in ft)	—/—/—	—/—/—	—/—/—	blade functions within its own dimensions. Application determines distances.				
b	Auxiliary Clearance, min WxHxL (in ft)	1 x 1 x 2.5	3 x 2.5 x 6.6	3.6 x 3.6 x 7.6	0	0	0	0	0
9	Working Ranges								
a	Loading:								
	(1) Size Opening WxH or WxL (in ft)	x	x	x	—	—	—	—	—
	(2) Forward Reach, max./min. (in ft)	/	/	/	—	—	—	—	—
	(3) Side Reach, max./min. (in ft)	/	/	/	—	—	—	—	—
	(4) Depth Reach, max./min (in ft)	/	/	/	—	1.3	1.3	1.1	0.6
	(5) Height (in ft)				—	—	—	—	—
b	Dumping:								
	(1) Size Opening WxH or WxL (in ft)	x	x	x	—	—	—	—	—
	(2) Horizontal Reach max./min. (in ft)	/	/	/	—	—	—	—	—
	(3) Height, max. (in ft)				—	—	—	—	—
	(4) Angle of Discharge (in deg.)				—	—	—	—	—
	(5) Direction of Discharge				—	—	—	—	—
	(6) Type				—	—	—	—	—
10	Working Power Applied by	C	C	C	C	P or C	P or C	P or C	P or C
11	Working Controls	M—A—AE	M—A—AE	M—A—AE	M	M or H	M or H	M or H	M or H
12	Traveling Clearances WxHxL (in ft)	—x—x—	—x—x—	—x—x—	14 x 5	12 x 5	12 x 4	10 x 4	10 x 3
13	Travel Speed: Empty: For./Rev. (in fpm)	—/165	—/330	—/330	see special remarks				
	Loaded: For./Rev. (in fpm)	150/—	250/—	250/—	see special remarks				
14	Grade Negotiable, max, Loaded/Empty (in %)	/	/	/	see special remarks				
15	Turning Radius, min (in ft)				na	na	na	na	na
16	Ground Pressure, Empty/Loaded (in psi)	/	/	/	8.4	8.37	8.37	7.15	6.45
18	Special Remarks:	None	None	None	Ref. to Notes for Col. 4	Ref. to Notes for Col. 5	Ref. to Notes for Col. 6	Ref. to Notes for Col. 7	Ref. to Notes for Col. 8

	Classification of Unit	Loader Front End Lift	Loader Front End Lift	Loader Front End Lift	Loader Front End Lift	Loader Front End Lift	Loader Front End Lift	Loader Front End Lift	Loader Front End Lift
	Model				18K3 Skid Shovel	933 Traxcavator	955 Traxcavator	977 Traxcavator	Michigan
	Manufacturer	Allis-Chalmers	Allis-Chalmers	Allis-Chalmers	Int. Harvester	Caterpillar	Caterpillar	Caterpillar	Clark Equip.
2	Mount	Crawler	Crawler	Crawler	Crwlr Self-P.	Cr.	Cr.	Cr.	Wheeled S-P
3a	Power: HP	204	150	72	105	50	70	100	80
b	Type	Diesel	Diesel	Diesel	Diesel	D	D	D	D or Gas
4a	Capacity: Vol. (in cu yd)	4.0	3.0	1.5	3	1.0	1.5	2.25	1.25
	Wt (in tons)	—	—	5.6	na	2.75	4.4	5.25	1.7
5a	Productive Output (in tons per hr)	400	350	185	na	87	135	193	245
b	At Transport Distance (in ft)	75	75	75	na	50	50	50	40
6a	Initial Cost (in $)	—	—	—	25,778	11,265	14,595	20,900	13,300
b	Additional per 100 ft haul (in $)	—	—	—	—	.00	.00	.00	—
c	Operating Cost ($ per ton per 100 ft haul)	—	—	—	na	.015	.0132	.0126	—
7a	Working Wt. Empty (in tons)	33.25	23.9	9.8	20.8	8.2	10.5	15.5	6.7
b	Additional per 100 ft haul (in tons)	—	—	—	—	—	—	—	—
8a	Working Clearances, min. H/W/L (in ft)	11/9.3/21.2	10.2/9.3/19.3	8.0/6.3/4.8	16.6/8.0/19.0	8/11/27	8/13/29	9/16/30	6.7/6.7/16.6
b	Auxiliary Clearance, min. W x H x L (in ft)	—x—x—	—x—x—	—x—x—	—x—x—	0	0	0	—x—x—
9	Working Ranges								
a	Loading:								
	(1) Size Opening W x H or W x L (in ft)	9.3x5.0	9.3x4.0	6.3x3.5	8.0xna	5.8	6.7	8.0	6.5x2.8
	(2) Forward Reach, max./min. (in ft)	—/—	—/—	—/—	—/—	3.3	4.0	4.2	—
	(3) Side Reach, max./min. (in ft)	—/—	—/—	—/—	—/—	—/—	—/—	—/—	—
	(4) Depth Reach, max./min. (in ft)	0.75/	0.67/	0.83/	1.16/	0.9	1.0	1.1	—
	(5) Height (in ft)	11.0	10.2	7.8	12.75	9.8	10.7	11.8	8.0
b	Dumping:								
	(1) Size Opening W x H or W x L (in ft)	9.3x5.0	9.3x4.0	6.3x3.5	na x	5.8	6.7	8.0	6.5x2.8
	(2) Horizontal Reach max./min. (in ft)	4.4/	4.1/	2.6/	na/	2.4	3.2	3.3	—
	(3) Height, max. (in ft)	11.0	10.2	8.0	10.33	7.8	8.3	9.3	8.0
	(4) Angle of Discharge (in deg.)	50	59	49	59	45	45	45	55
	(5) Direction of Discharge	Front	Front	Front	Front	F	F	F	F
	(6) Type	Tilt	Tilt	Tilt	Drop	D	D	D	Tilt
10	Working Power Applied by	Piston	Piston	Piston	Piston	P	P	P	P. Hyd.
11	Working Controls	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic
12	Traveling Clearances W x H x L (in ft)	9.3x8.8x21.2	9.3x8.3x19.3	6.3x5.6x14.8	8.0x16.6x19.0	6x6x14	7x7x15	8x7x17	6.9x6.7x17.1
13	Travel Speed: Empty: For./Rev. (in fpm)	563/308	633/484	485/360	537/334	528/264	607/264	651/816	2290/2290
	Loaded: For./Rev. (in fpm)	563/308	633/484	485/360	537/334	308/264	308/264	352/440	2290/2290
14	Grade Negotiable, max. Loaded/Empty (in %)	100/	100/	100/	na/	52/70	48/67	47/63	50/60
15	Turning Radius, min. (in ft)	—	—	10.4	8.0	28	29	30	17.4
16	Ground Pressure, Empty/Loaded (in psi)	11.7/14.2	10.3/12.6	9.1/11.4	12.1/na	9.3	8.5	8.3	20.8/26.6
18	Special Remarks:	COMPLETE TRACTOR-LOADER UNIT				Ref. to Notes for Col. 18	Ref. to Notes for Col. 19	Ref. to Notes for Col. 20	Ref. to Notes for Col. 21

1	Bulldozer Straight Blade only	Bulldozer Straight	Bulldozer Straight	Bulldozer Straight	Bulldozer Straight
		Complete Tractor-Dozer Unit			
	No. 4 Caterpillar	Allis-Chalmers	Allis-Chalmers	Allis-Chalmers	24-D-1 Int. Harvester
2	P	Crawler	Crawler	Crawler	Crawler
3a	—	204	150	66.5	190
b	N	Diesel	Diesel	Diesel	Diesel
4a	2.08	5.7	4.02	1.6	6.00
b	4.28	23.8	17.5	6.7	10.5
5a	72	409	280	140	200
b	300	100	100	100	200
6a	1,595	—	—	—	30,766
b	—	—	—	—	O
c	.0035	—	—	—	na
7a	1.5	26.5	19.5	7.5	25.89
b	—	—	—	—	O
8a		8.3/12.1/20.0	7.4/11.1/18.2	5.6/8.0/12.3	8.1/11.3/19.7
b	O	—			
9					
a					
(1)	—	12.1 x 4.0	11.1 x 3.5	8.0 x 2.6	54.5 sq ft.
(2)	—	—	—	—	—
(3)	—	—	—	—	—
(4)	0.9	—	—	—	Unlimited
(5)	—	—	—	—	4.833
b					
(1)	—	—	—	—	x
(2)	—	—	—	—	+
(3)	—	—	—	—	—
(4)	—	—	—	—	—
(5)	—	—	—	—	—
(6)	—	—	—	—	—
10	P	Cable	Cable	Hydraulic	Cable
11	H	Mechanical	Mechanical	Hydraulic	Mechanical
12	8 x 3	8.3 x 12.1 x 20.0	7.4 x 11.1 x 18.2	5.6 x 8.0 x 12.3	11.3 x 8.1 x 19.7
13	———	660/485	635/485	485/176	704/697
	———	660/485	635/485	485/176	704/697
14	———	100	100	100	na
15	na	—	—	—	9.833
16	6.8	—	—	—	11.5/na
18	Ref. to Notes for Col. 9	None	None	None	Ref. to Notes for Col. 13

NOTES:

Col. 4-9
- Line 5a Bulldozed quantities can be increased by as much as 75% with trenching and downhill dozing.
- Line 5b Distance is for computation only, not to be construed as recommended by manufacturer.
- Line 6c Figured as an average operation cost including repairs, under average conditions. Distance of haul has not been considered.
- Line 9a(4) Depth of blade during operation unlimited when working power applied by cable—Dimensions used above apply only in the use of hydraulic power.
- Line 13 & 14 Speed and grade negotiation depend on prime mover.
- Line 16 Given ground pressure is for prime mover.

Col. 13
- Line 7 This is largest bulldozer unit I. H. produces. The one specified on this page is a gear driven unit as opposed to our optional TD-24 torque converter unit. A rear cable control unit (Model 24 D-3) & direct lift hydraulic bulldozers (Model 24 D-2 & Model 24 G-2) are also available.

Col. 18-20
- Line 5b 6c As for Col. 4-9.
- Line 9a(5) Height to lift pin.

Col. 21-23
- Features 4-wheel drive, rear wheel steer; Clark power shift transmission, torque convertor (3 to 1 mutip. factor), and planetary axles; and 24v electrical system. Complete unit engineered and manufactured by Clark.

Col. 24-25
- Line 6c From limited operating reports.
- Line 9b(4) Buckets made special to suit conditions.
- Line 15 Unit designed to turn by reversing one track and not braking.

Col. 26&27
- Line 5b Car should be coupled to loader hence no travel.
- Line 6a Air model.
- Line 9b(2) Dump reach is to rear.
- Line 9b(4) Buckets made special to suit conditions.
- Line 14 Equipped with Eimco slope device.
- Line 15 & 16 Railroad type.

Col. 28
- Line 1 Combination overdump with integral belt conveyor.
- Line 5b Car should be coupled to loader hence no travel.
- Line 6a Air model.
- Line 9b(1) Discharge belt width.
- Line 9b(2) Dump reach is to rear.
- Line 9b(3) Discharge belt height.
- Line 9b(4) Buckets made special to suit conditions.
- Line 9b(6) Belt discharge is Drop although bucket discharge to belt is Tilt Cast.
- Lines 15 & 16 Railroad type.

Col. 29
- Line 6a Air model.
- Line 9b(2) Dump reach is to rear.
- Line 9b(4) Buckets made special to suit conditions.

1	Loader Front End Lift Michigan	Loader Front End Lift Michigan	Loader Front End Lift 105 FEL	Loader Overdump 105 OHL	Loader Overdump 12B	Loader Overdump 21	Loader Overdump 40H	Loader Overdump 630
	Clark Equip.	Clark Equip.	Eimco	Eimco	Eimco	Eimco	Eimco	Eimco
2	Wheeled S-P	Wheeled S-P	Crwlr S-Pro	Crwlr S-Pro	Rail W S-P	Rail W S-P	Rail W S-P	Crawlr S-P
3a	120	133	143	143	2@7.5	2@12	2@18, 2@7.5	3@12
b	D or Gas	D or Gas	Diesel	Diesel	Air	Air or Elec	Air or Elec	Air or Elec
4a	2.0	2.75	2.5	1.5	0.17-0.22	0.28-0.37	0.33-0.48	0.22-0.45
b	2.75	3.75	6.0	6.0	.9	1.02	2.8	2.0
5a	330	390	1040	623	105	184	320	180
b	40	40	10	10	See Remarks	See Remarks	See Remarks	15
6a	17,500	21,000	26,500	25,400	3370.	4720.	14430.	9800.
b	—	—	—	—	—	—	—	—
c	—	—	.020	.020	.006	.005	.010	.006
7a	8.8	12.8	22.0	20.0	2.25	3.6	8.4	5.0
b	—	—	—	—	—	—	—	—
8a	7.2/7.4/17.9	7.8/8.3/19.7	9.1x7.9x17.2	17.6x7.7x16.0	6.0x3.0x8.0	7.3x4.0x9.6	7.5x6.0x21.0	8.0x5.7x11.0
b	—x—x—	—x—x—	9.1x7.9x17.2	17.6x7.7x16.0	—	—	—	—
9								
a								
(1)	7.6x3.3	8.0x3.8	10.0x10.0	10.0x18.0	2.5x2.5	3.0x2.5	3.5x3.0	4.5x2.5
(2)	—	—/—	4.5	5.9	4.25	5.2	8.3	7.5
(3)	—	—/—	—	—	3.5x4.5	5.0x4.0	6.0x7.0	—
(4)	—	—/—	1.2	1.5	.3x.2	.3x.2	.75x.4	1.9x.1
(5)	8.2	8.5	14.5	11.5	5.75	6.5	7.0	7.25
b								
(1)	7.6x3.3	8.0x3.8	8.0x8.0	8.0x8.0	2.5x2.0	3.0x2.5	2.5 wide	4.5x2.5
(2)	—	—/—	4.5	5.6x5.0	2.0x1.16	2.3x1.5	10.0/7.0	2.0/1.5
(3)	8.2	8.5	11.5	11.5	5.0	5.6	6.5	7.1
(4)	55	55	50	See Remarks	See Remarks	See Remarks	See Remarks	See Remarks
(5)	F	F	F	R	R	R	R	R
(6)	Tilt	Tilt	Tilt	Tilt Cast	Tilt Cast	Tilt Cast	See Remarks	Tilt Cast
10	P. Hyd.	P. Hyd.	P. Hyd.	G	G	G	G	G
11	Hyd.	Hyd.	H	M	M	M	M	M
12	7.8x7.2x18.2	8.3x7.8x20.2	7.9x9.1x17.2	7.7x9.5x16.0	2.5x4.0x6.0	3.0x4.8x7.3	6.0x8.0x20.5	5.0x5.0x9.2
13	2110/2110	2110/2110	200/480	200/480	0/268	0/268	0/268	0/134
	2110/2110	2110/2110	200/480	200/480	0/268	0/268	0/268	0/134
14	50/60	50/60	70/100	70/100	100	100	20	70
15	9.3	21.1	7.0 (R)	7.0 (R)	See Remarks	See Remarks	See Remarks	3.9 (R)
16	30.3/60.0	31.6/63.0	12	12	See Remarks	See Remarks	See Remarks	12
18	Ref. to Notes for Col. 22	Ref. to Notes for Col. 23	Ref. to Notes for Col. 24	Ref. to Notes for Col. 25	Ref. to Notes for Col. 26	Ref. to Notes for Col. 27	Ref. to Notes for Col. 28	Ref. to Notes for Col. 29

Some Suggested Classifications

Dredges, Floating: Bucketline, Dipper Shovel, Dragline, Grab or Suction.

Excavator - Loaders, Bucketwheel or Bucketline.

Excavator-Loaders, Power Shovel & Crane Type: Dipper Shovel, Dragline Crane, Grab Crane or Hoe Shovel; Skimmer, Shortboom or High Lift.

Excavator-Loaders, Scoop Type: Arc Load (Gismo, etc.), Front End Lift (most tractor shovels) or Overdump (mine muckers, overloaders, rolling bucket, etc.)

Excavator - Loaders, Digger - Conveyor: Gathering Arm (Joy, Jeffrey, etc.), Arc Load (Conway, etc.), Rotary Vane, Paddle-line, Screw, Plow or other digging component & Belt, Pan, Scraper-Drag Chain or other elevating-conveying component.

Excavator-Loaders, Special Tunnel.

Excavator-Loaders, Special Mine Shaft Sinking.

Bulldozers, Straight or U Blade.

Dragline Scraper-Slushers: Two or Three Drum, Axial or Tandem.

Conveyors, Stationary or Movable Unit (not those with self-loading device): Belt, Pan (includes Apron), Scraper-Drag, Screw, Shaking-Vibrating, Bucket, Pneumatic or other.

Railroad Vehicles: Cars or Locomotives.

Mobile Vehicles: Trucks, Semi-Trailers or Full-Trailers.

Aerial Tramways (horizontal movement only) or Cableways (vertical and horizontal movement).

Skips & Skip Hoists.

Hydraulic Monitors (Nozzles).

Pumps, Sand & Dredge.

Bridge & Gantry Cranes.

Monorail Carriers, trolley or ground.

MUCK HANDLING

1	Classification of Unit	Loader Dipper Shovel	Loader Dipper Shovel	Loader Dipper Shovel	Loader Dipper Shovel	Loader Dipper Shovel	Loader Dipper Shovel	Loader Dipper Shovel	Loader Dipper Shovel	Loader Dipper Shovel
	Model	LS-58	LS-98	K-608	205	305	405	605	805	1205
	Manufacturer	Link-B. Speeder	Link-B. Speeder	Link-B. Speeder	Koehring	Koehring	Koehring	Koehring	Koehring	Koehring
2	Mount	Crawler	Crawler	Crawler	C	C	C	C	C	C
3a	Power: HP	55	99	276	61	75	101	130	160	230
b	Type	Gas	Gas	Diesel	GE	G	G	D	D	D
4a	Capacity: Vol. (in cu yd)	0.5	1	3	0.5	0.75	1.0	1.5	2.0	3
b	Wt (in tons)	—	—	—	10	15	20	36	52.1	95
5a	Productive Output (in tons per hr)	130	275	630	105	166.25	218.75	315.0	402.5	551.25
b	At Transport Distance (in ft)	—	—	—	—	—	—	—	—	—
6a	Initial Cost (in $)	19,665	34,650	90,870	19350	27000	36800	54250	68900	95450
b	Additional per 100 ft haul (in $)	—	—	—	—	—	—	—	—	—
c	Operating Cost ($ per ton per 100 ft haul)	—	—	—	—	—	—	—	—	—
7a	Working Wt. Empty (in tons)	14.6	27.4	87	13.9	21.5	27.25	48.75	56.5	89.2
b	Additional per 100 ft haul (in tons)	—	—	—	—	—	—	—	—	—
8a	Working Clearances, min. H/W/L (in ft)	10.2/8.7/32.8	11/10.3/38.8	17.2/12.8/54.5	17/23.2/23.2	19.6x26x26	22.5x29.7x29.7	24.1x31.75x 31.75	26.1x34.8x34.8	31x40.75x40.75
b	Auxiliary Clearance, min. W x H x L (in ft)	—x—x—	—x—x—	—x—x—	—	—	—	—	—	—
9	Working Ranges									
a	Loading:									
(1)	Size Opening W x H or W x L (in ft)	2.5x2	3.2x2.6	4.2x4.9	2.5x2.1	2.9x2.4	3.2x2.7	3.6x3.2	4x3.5	4.8x4
(2)	Forward Reach, max./min. (in ft)	24.0/—	28.6/—	40.0/—	23.9/6.7	27.9—8.3	30.4—9.2	31.9—9.0	35.5—10.2	42.1/11.3
(3)	Side Reach, max./min. (in ft)	24.0/—	28.6/—	40.0/—	23.9/6.7	27.9—8.3	30.4—9.2	31.9—9.0	35.5—10.2	42.1/11.3
(4)	Depth Reach, max./min. (in ft)	5.9/—	7.3/—	9.8/—	4.9/—	7.3—	6.8—	7.6—	9.1—	10.75
(5)	Height (in ft)	21.0	23.6	33.0	20.7	22.8	26.1	27.4	30.4	35.3
b	Dumping:									
(1)	Size Opening W x H or W x L (in ft)	2.5x2	3.2x2.6	4.2x4.9	2.6x2.2	3.0x2.6	3.3x2.8	3.8x3.3	4.1x3.7	4.9x4.2
(2)	Horizontal Reach max./min. (in ft)	24.0/—	28.6/—	40/	22.1/—	25.5—	28.0—	28.1—	31.4	38.3—
(3)	Height, max. (in ft)	14.6	16.3	21.8	14.4	15.7	18.6	18.8	20.4	24.2
(4)	Angle of Discharge (in deg.)	na	na	na	90	90	90	90—	90—	90
(5)	Direction of Discharge	na	na	na	B	B	B	B	B	B
(6)	Type	Drop Door	Drop Door	Drop Door	D	D	D	D	D	D
10	Working Power Applied by	Cable & Chain	Cable & Chain	Cable & Chain	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr
11	Working Controls	Hydraulic	Hydraulic	Hydraulic	M	M	M	M	MA	MA
12	Travel Clearances W x H x L (in ft)	x x	x x	x x	—	—	—	—	—	—
13	Traveling Speed: Empty: For./Rev. (in fpm)	176.8/176.8	149.6/149.6	74/74	88/83	83/83	70/70	78/78	62/62	49/49
	Loaded: For./Rev. (in fpm)	—/—	—/—	—/—	—	—	—	—	—	—
14	Grade Negotiable, max. Loaded/Empty (in %)	35/35	35/35	35/35	30/—	30/—	30/—	30/—	30/—	30/—
15	Turning Radius, min. (in ft)	10.2 (B)	12.3 (B)	16.7 (B)	—	—	—	—	—	—
16	Ground Pressure, Empty/Loaded (in psi)	5.8/—	8.9/—	13/—	8.78/—	8.94—	9.16—	14.6—	15.7—	14.7—
18	Special Remarks:	Ref. to Notes for Col. 30	Ref. to Notes for Col. 31	Ref. to Notes for Col. 32	Ref. to Notes for Col. 33	See Col. 33	See Col. 33	See Col. 33	See Col. 33	See Col. 33

1	Classification of Unit	Truck	Truck	Truck	Semi-Trailer 2 or 4-wh Tractor Comb;	Semi-Trailer 2 or 4-wh Tractor Comb;	Semi-Trailer 2-wh Tractor Comb;	Semi-Trailer 2-wh Tractor Comb;	Semi-Trailer 4-wh Tractor Comb;	Semi-Trailer 4-wh Tractor Comb;
	Model	Dumptor	Ore-Master	95 Payhauler	Wagon C&D Movall 12B	Wagon C&D Movall 12B	Wagon Motor Wagon	Wagon Motor Wagon	Scraper DW 15	Scraper DW 20
	Manufacturer	Koehring	Ortruc	Int. Harvester	Yuba	Yuba	Allis-Chalmers	Allis-Chalmers	Caterpillar	Caterpillar
2	Mount	Wheeled S-P	Wheels	Wheel S-P	Wheeled	Wheeled	Wheel	Wheel	W. Pro.	W. Pro.
3a	Power: HP	109	45	335	(300)	(186)	200	280	200	300
b	Type	Diesel	Diesel	Diesel	(Diesel)	(Diesel)	Diesel	Diesel	D	D
4a	Capacity: Vol. (in cu yd)	5.25	2.5	16	14	12	11	17	13	18
b	Wt (in tons)	8.25	8	24	32	22	18	26	19.5	27.5
5a	Productive Output (in tons per hr)	—	na	175.2	—	—	180	260	213	317
b	At Transport Distance (in ft)	3000	na	3000	—	—	2600	2600	2,500	2,500
6a	Initial Cost (in $)	15,300	na	39,070	—	—			33,420	45,085
b	Additional per 100 ft haul (in $)	—	—	0	—	—	—	—	00	00
c	Operating Cost ($ per ton per 100 ft haul)	—	na	na	—	—	—	—	.024	.021
7a	Working Wt. Empty (in tons)	8.25	5	24.55	17	22	21.9	23.5	22.5	28.55
b	Additional per 100 ft haul (in tons)	—	—	—	—	—	—	—	—	—
8a	Working Clearances, min. H/W/L (in ft)	11.0/8.5/16.0	10.2/6.5/18	21.7/10.9/26.8	12.5/11.3/25.3	10.5/10.2/19.0	10.3/10.8/27.2	10.0/11.3/35.8	8.8 x 10.4	11.0 x 12.0
b	Auxiliary Clearance, min. WxHxL (in ft)	—x—x—	—x—x—	—x—x—	—	—		—x—x—	O	O
9	Working Ranges									
a	Loading:									
(1)	Size Opening WxH or WxL (in ft)	8.0 x 8.0	6.0 x 9.0	10.9 x 15.3	11 x 19	10 x 16	8.0 x 11.3	8.4 x 12.5	8.5	10.3
(2)	Forward Reach, max./min. (in ft)	/	+	—/—	—	—		/	—	—
(3)	Side Reach, max./min. (in ft)	/	+	—/—	—	—	—	/	—	—
(4)	Depth Reach, max./min. (in ft)	/	+	—/—	—	—		/	1.0	See Remarks
(5)	Height (in ft)	6.0	4.5	13.75	—	—			—	—
b	Dumping:									
(1)	Size Opening WxH or WxL (in ft)	8.0 x 8.0	6 x —	10.9 x 15.3	—	—	W 8.0 x	5.7 x 11.5	8.5	10.3
(2)	Horizontal Reach max./min. (in ft)	/	+	—/—	—	—		/	—	—
(3)	Height, max. (in ft)	—	X	1.17	—	—			—	—
(4)	Angle of Discharge (in deg.)	70	65	65	—	—			—	—
(5)	Direction of Discharge	R	Rear	Rear	Rear	Rear	Rear	Bottom	F	F
(6)	Type	T	Tilt	Tilt	Ejector Blade	Ejector Blade	Power Tip Out	Doors Open	E	E
10	Working Power Applied by	Gr	Piston	Hydraulic	Cable	Cable	Piston	Piston	C	C
11	Working Controls	M H	X	Mech & Hyd.	Power	Power	Hyd	Hyd	M	M
12	Travel Clearances WxHxL (in ft)	8.5x8.75x14.5	5.5 x 6.5 x 18	10.9x11.0x26.8	—	—		—x—x—	11 x 10 x 40	12 x 11 x 44
13	Traveling Speed: Empty: For./Rev. (in fpm)	1510/1510	X/X	3344/1625	na	na	1760/264	1760/264	3274-449	2625-413
	Loaded: For./Rev. (in fpm)	1510/1510	2400/2400	2745/na	—	—	1760/264	1760/264	1003-361	792-325
14	Grade Negotiable, max, Loaded/Empty (in %)	24/24	15/X	42/41.2	8/17.5	8/17.5	26/	22/	22.0/23.1	19.8/23.5
15	Turning Radius, min. (in ft)	19.25	23	30.5	30	27	16	31.3	34	50
16	Ground Pressure, Empty/Loaded (in psi)	23.3/55.3	X/X	na/na	40/88	—	/	/	31.5	31.5
18	Special Remarks:	Ref. to Notes for Col. 48	Ref. to Notes for Col. 49	Ref. to Notes for Col. 50	Ref. to Notes for Col. 51	Ref. to Notes for Col. 52	Rear Dump See Col. 59	Bottom Dump See Col. 59	Ref. to Notes for Col. 55	Ref. to Notes for Col. 56

1	Loader Dipper Shovel High Lift 605 Koehring	Loader Dipper Shovel High Lift 1205 Koehring	Loader Dipper Shovel High Lift 1205 Koehring	Loader Dragline Crane 205 Koehring	Loader Dragline Crane 305 Koehring	Loader Dragline Crane 405 Koehring	Loader Dragline Crane 605 Koehring	Loader Dragline Crane 805 Koehring	Loader Dragline Crane 1205 Koehring
2	C	C	C	C	C	C	C	C	C
3a	130	230	230	61	75	101	130	160	230
b	D	D	D	GE	G	G	D	D	D
4a	1.5	3	3	0.5	0.75	1.0	1.5	2.0	3
b	36	95	95	10	15	20	36	52.1	95
5a	332.5	—	—	131.25	183.75	236.25	332.50	402.5	516.25
b	—	—	—	—	—	—	—	—	—
6a	55500	109800	109000	17400	23500	31900	47850	62150	85850
b	—	—	—	—	—	—	—	—	—
c	—	—	—	—	—	—	—	—	—
7a	53.1	109.5	109.5	14.35	21.25	26.75	46.25	55.3	84.3
b	—	—	—	—	—	—	—	—	—
8a	28.4x36.75x-36.75	45.2x56.9x56.9	37.75x50.2x-50.2	27/33.5/33.5	30x36.9x36.9	35x36.9x36.9	43x52x52	42x52.3x52.3	51x63.5x63.5
b	—	—	—	—	—	—	—	—	—
9									
a									
(1)	3.6 x 3.2	4.3 x 3.75	4.8 x 4	—	—	—	—	—	—
(2)	41.1-9.75	62.75-9.75	52.6-9.9	25/—	27.5-	32-	39-	39-	48-
(3)	41.1-9.75	62.75-9.75	52.6-9.9	25/-	27.5/	32-	39-	39-	48-
(4)	10.6- —	11.3	9.0	—	—	—	—	—	—
(5)	34.3 —	51.3	42.8	27	29	34	43	42	51
b									
(1)	3.8 x 3.3	4.5 x 3.9	4.9 x 4.2	—	—	—	—	—	—
(2)	38.2 —	59.7 —	49.0	25/	28	34	40	39	48
(3)	25.75	20.0	15.3	25	28	34	43	39	48
(4)	90	90	90	90	90	90	90	90	90
(5)	B	B	B	B	B	B	B	B	B
(6)	D	D	D	T	T	T	T	T	T
10	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr	C, Ge & Gr
11	M	MA	MA	M	M	M	M	MA	MA
12	—	—	—	—	—	—	—	—	—
13	78/78	49/49	49/49	88/88	83/83	70/70	78/78	62/82	49/49
14	30 / —	30 / —	30 / —	30 / —	30 / —	30 / —	30 / —	30 / —	30 / —
15	—	—	—	—	—	—	—	—	—
16	16.0 —	15.1 —	15.1 —	9.02 / —	8.86 —	8.96 —	13.9 —	15.4 —	13.8 —
18	See Col. 33	See Col. 33	See Col. 33	See Col. 33	See Col. 33	See Col. 33	See Col. 33	See Col. 33	See Col. 33

1	Semi-Trailer 2-wh Tractor Comb; Scraper DW 21 Caterpillar	Semi-Trailer 2-wh Tractor Comb; Scraper 75 Payscraper Int. Harvester	Semi-Trailer 2-wh Tractor Comb; Scraper Motor Scraper Allis-Chalmers	Semi-Trailer 2-wh Tractor Comb; Scraper Motor Scraper Allis-Chalmers	Full Trailer 2-wh Tractor Scraper Scraper No. 491 Caterpillar	Full Trailer Scraper No. 463 Caterpillar	Full Trailer Scraper No. 70 Caterpillar	Full Trailer Scraper No. 60 Caterpillar	Full Trailer Scraper No. 40 Caterpillar
2	W Pro.	Wheel S-P	Wheel S-P	Wheel S-P	W T	W T	W T	W T	W T
3a	300	262	260	200	—	—	—	—	—
b	D	Diesel	Diesel	Diesel	N	N	N	N	N
4a	18	20 (heaped)	15	11	27	18	10.2	7	3.6
b	27.5	27.5	25	18	41	27.5	16.5	11.5	6
5a	403	355.5*	250	180	450	256	169	124	61
b	2,500	1000	2600	2600	1,000	1,000	1,000	1,000	1000
6a	44,990	39,415	—	—	23,100	16,575	10,635	7,295	4,275
b	.00	0	—	—	.00	.00	.00	.00	.00
c	.017	na	—	—	.0037	.0073	.0049	.0046	.0067
7a	28.5	26.85	24.5	19.8	18.5	15.5	10	7	4
b	—	0	—	—	—	—	—	—	—
8a	11.0 x 12.0	9.2/11.5/39.3	10.4/11.5/36.5	9.9/10.9/34.1	11 x 12	11.5 x 12	9 x 10.5	8x 9.5	6 x 8
b	0	x na x	x x	x x	0	0	0	0	0
9									
a									
(1)	10.3	na x	9.7 x 8.5	8.5 x 8.0	10.0	10.3	8.5	7.7	6.0
(2)	—	—/	/	/	—	—	—	—	—
(3)	—	—/	/	/	—	—	—	—	—
(4)	See Remarks	Unlimited	/	/	Any practical depth		1.0	0.9	0.6
(5)	—	na			—	—	—	—	—
b									
(1)	10.3	na x	9.7 x 8.5	8.5 x 8.0	10.0	10.3	8.5	7.7	6.0
(2)	—	—/	/	/	—	—	—	—	—
(3)	—	—			—	—	—	—	—
(4)	—	—			—	—	—	—	—
(5)	F	Bottom	Forward	Forward	F	F	F	F	F
(6)	E	Positive	Forced	Forced	E	E	E	E	E
10	C	Cable	Cable	Cable	C	C	C	C	P
11	M	Cable	Power Hyd	Power Hyd	M	M	M	M	Hy.
12	12 x 11 x 42	11.5x9.2x39.3	x x	x x	12 x 11 x 40	12 x 11 x 38	10 x 9 x 31	9 x 8 x 28	8 x 6 x 21
13	1800-264	2,112/211.5	1760/264	1760/264	See special remarks				
	660-264	na	/	/	See special remarks				
14	26.2/38.8	na	26/	26/	See special remarks				
15	36	46.583	31.5	18	32	29	25	22	19
16	31.5	na	/	/	31.5	31.5	31.5	31.5	31.5
18	Ref. to Notes for Col. 57	Ref. to Notes for Col. 58	Ref. to Notes for Col. 59	See Col. 59	Ref. to Notes for Col. 61	See Col. 61	See Col. 61	See Col. 61	See Col. 61

NOTES:

Col. 30-32
- Line 3a (Col 32 only) Stripped.
- Line 8a All clearances are maximum length—cutting raduis plus tail swing
- Line 9a All loading dimensions are with boom @ 45°
- Line 9b All dumping dimensions are with boom @ 45°
- Line 10 Cable used to hoist bucket and chain is used to crowd
- Line 11 True power hydraulic controls
- Line 15 One crawler is braked while the other is powered to turn machine in length of track

Col. 33
- Lines 8a-9b(6) With boom at 45°

Col. 48
- Line 9b(5) Or rear depending on direction of travel
- Line 16 Pressures are drive axle figures

Col. 49
- Line 7a With scrubber for underground
- Line 13b Max on 15% Grade, 5-7 mph. Has Allison Torqmatic transmission with torque convertor.

Col. 50
- Line 5b
  - Load: 2.067 sec.
  - Haul: 2.27 sec (@ 15 mph)
  - Dump: .20. "
  - Return: 2.27 sec.
  - Total 6.807 sec
  - Trips/Hr. (50 min.) $\frac{50}{6.807} = 7.3$
- Line 9a(1) Quarry body.
- Line 13 Nine speeds.

Col. 51
- Prime movers used to pull Movalls are: rubber tired, 300 hp by Caterpillar, Allis-Chalmers, or International-Harvester.
- Line 4b 25 cu yd, Heaped
- Line 9b(6) Positive ejection to rear, no tilt

Col. 52
- Prime movers used to pull Movalls are: rubber tired 186 hp by Caterpillar or Allis-Chalmers.
- Line 4b 16 cu yd, Heaped
- Line 9b(b) Positive ejection to rear, no tilt.

Col. 55-57
Complete unit.
- Line 5b Distance is for computation only, not to be construed as recommended by Mfg.
- Line 6c Figured as an average operation cost including repairs, under average conditions distance of haul has not been considered.
- Line 8a Dumping and loading distances depend upon application.
- Line 9a(4) Depth of bowl during operation depends upon application, soils, operator, etc.

Col. 58
- Line 5a Sandy soil—2850 lb/yd (Bankyard)

Col. 59
- The Motor Scraper and Motor Wagon consists of single axle wheel tractor and single axle wheel scraper or single axle wheel wagon being hooked together and becoming a highly maneuverable self-propelled prime mover.

Col. 61
- Line 5b-9a (4) See notes for Col. 55-57
- Line 13&14 Speed and grade negotiation depends on prime mover

Shaft Mucking Machines Can Fit Most Conditions

SHAFT MUCKING was long a tough hand labor holdout. The inclined shaft is more difficult to mechanize than the vertical. Units for both are shown here. Published reports lack consistant measure of performance, but we have attempted to convert available data into volume loaded by a single unit per unit time. It has limitations since hoisting, moving and delay times are not necessarily included. Nor does it consider elements of labor time, equipment cost, muck sizes, etc.

Rail mounted slusher slide, 5 cu ft semi-box bucket (Fig. 1) and three bottom men mucked 80 cu yd (solid) per shift—including hoisting—in 10x30-ft 33½ deg incline. Tail blocks were pinned to ribs. (*E&MJ*, December 1948).

Wheeled slusher bucket and track frame (Fig. 2) was used on at least two 45-deg inclines. One was 65 sq ft the other 9 ft dia. (*E&MJ*, December 1950).

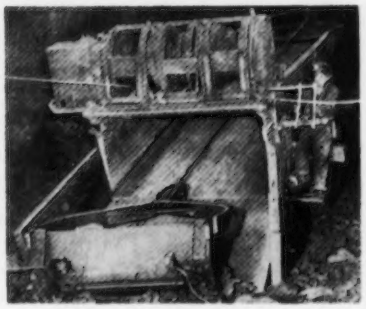
Self-loading 1/3 cu yd skip (Fig. 3) was designed by S. W. McDougal for 1,100-ft, 50-deg incline. Three machines, one in each compartment, each moved about 3 1/3 cu yd (loose) per hour up into footwall bin. (*E&MJ*, August 1949).

Dragline arrangement with 13-cu ft bucket operated from triple deck cage was used by N. J. Zinc in New Jersey to load skips while sinking an 8x18-ft, 52-deg shaft. Sheaves were pinned to back and ribs. (*MCJ*, October 1952).

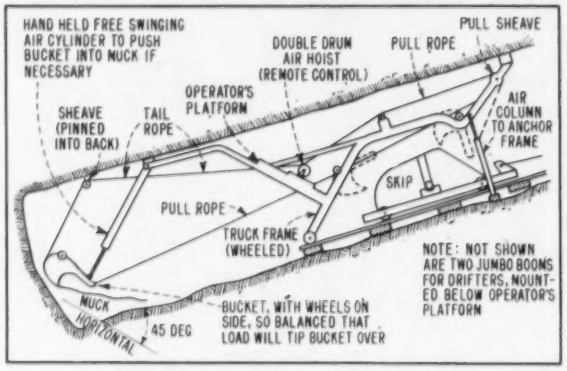
Shovel (Fig. 4) by Boskovich and Hall was for 7x17-ft vertical shaft. Four bottom men mucked 5-ft advance in 2 shifts but actually loaded 22 cu yd (loose) per hr and with hoisting, removed 11 yd per hr. (*E&MJ*, June 1948).

For vertical shafts grab bucket set-ups are common. Leading bucket designs are shown in Fig. 5 to 9. Simplest scheme is to use remote controlled surface crane or small air hoist near shaft bottom.

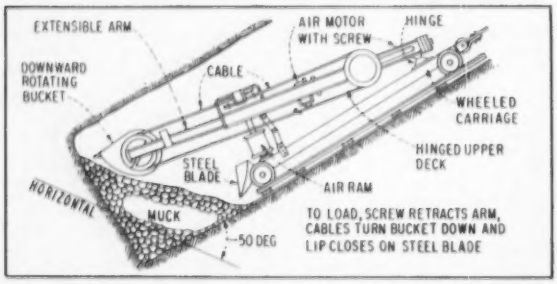
Compact layout (Fig. 10) uses Bucyrus-Erie's Hyro-mucker equipment. On 15x20-ft, vertical shaft—151 ft per



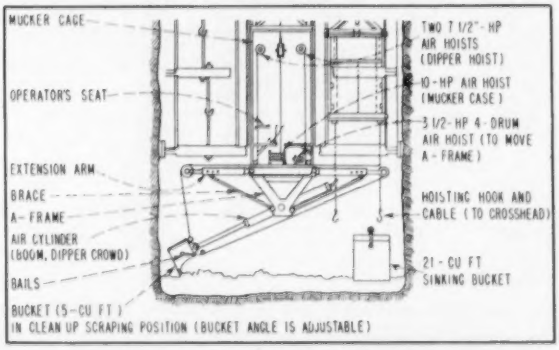
1. Slusher slide—Republic Steel, N. Y.


HAND HELD FREE SWINGING AIR CYLINDER TO PUSH BUCKET INTO MUCK IF NECESSARY
DOUBLE DRUM AIR HOIST (REMOTE CONTROL)
PULL SHEAVE
PULL ROPE
OPERATOR'S PLATFORM
SHEAVE (PINNED INTO BACK)
TAIL ROPE
AIR COLUMN TO ANCHOR FRAME
SKIP
PULL ROPE
TRUCK FRAME (WHEELED)
NOTE: NOT SHOWN ARE TWO JUMBO BOOMS FOR DRIFTERS, MOUNTED BELOW OPERATOR'S PLATFORM
MUCK
HORIZONTAL
45 DEG
BUCKET, WITH WHEELS ON SIDE, SO BALANCED THAT LOAD WILL TIP BUCKET OVER

2. Wheeled slusher & track—Killingdal, Norway



3. Self-loading skip—Bunker Hill & Sullivan, Idaho


MUCKER CAGE
OPERATOR'S SEAT
EXTENSION ARM
BRACE
A-FRAME
AIR CYLINDER (BOOM, DIPPER CROWD)
BAILS
BUCKET (5-CU FT) IN CLEAN UP SCRAPING POSITION (BUCKET ANGLE IS ADJUSTABLE)
TWO 7 1/2"-HP AIR HOISTS (DIPPER HOIST)
10-HP AIR HOIST (MUCKER CASE)
3 1/2-HP 4-DRUM AIR HOIST (TO MOVE A-FRAME)
HOISTING HOOK AND CABLE (TO CROSSHEAD)
21-CU FT SINKING BUCKET

4. Dipper shovel New Park Mining, Utah

5. Joy Mfg.

6. Ruhr. Ind.

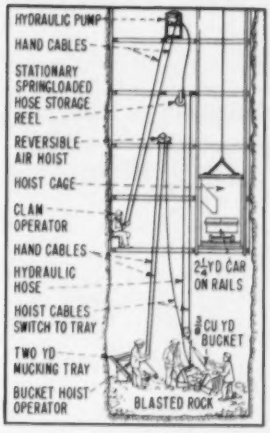
7. Bucyrus-Erie

8. Blaw-Knox

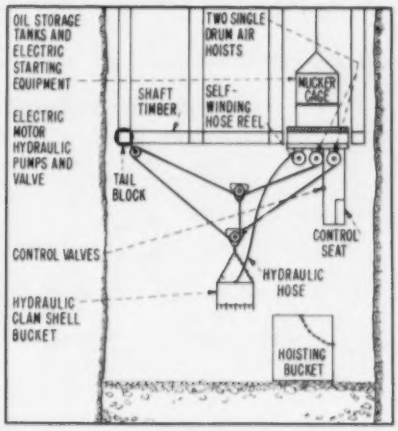
9. Anglo-Amer.

ORANGE PEEL bucket can be operated by air ram (5) or cable (6). Joy's is said to average 25 cu yd per hr.

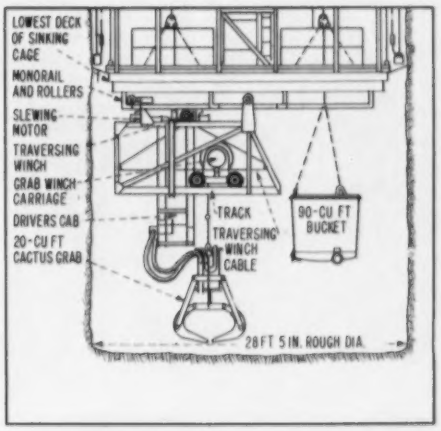
CLAM SHELLS come with hydraulic cylinder (7), integral air hoist (8) and air ram (9) closing devices.



10. Simple hoist

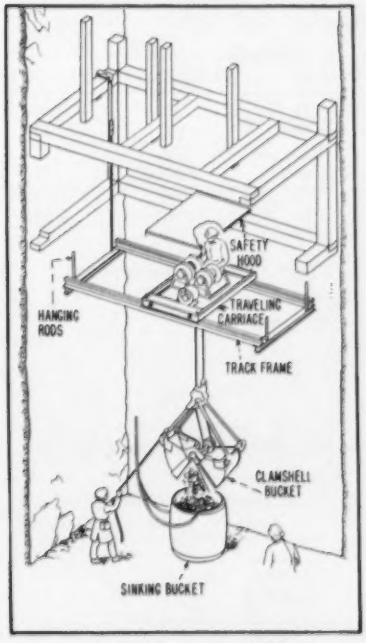


11. Cableway—Boland Dev.



12. Monorail-bridge crane—Vlakfontein, S. Africa

13. Jib crane—Anglo-American, S. Africa



14. Bridge crane—Riddell

month below 1400-ft—output was 11 cu yd (loose) per hr with total crew of 7. (*ME*, June 1949).

Cableway (Fig. 11) uses same equipment. In 15x22-ft vertical shaft below 2,500 ft, advance per shift about 3 ft, two units side by side each mucked over 11 cu yd (loose) per machine hr. (*CMM* Bull, Nov 55).

Bridge crane type apparatus, mounted on monorail, centrally pivotted (Fig. 12), helped sink 24-ft dia vertical shaft 585 ft in one month. Mucking was 67 cu yd (loose) per hr. Unit is sold by Sturrock & Co. (*E&MJ*, August 1953).

Boom (Fig. 13) by Robert Blair uses hydraulic ram grab and electric winches. Having little bulk, it permits using more hoist buckets for faster mucking. (*Optima*, September 1956).

Bridge crane (Fig. 14) can also be used on additional circular track or on second traversing track. In 7x24-ft vertical shaft to 1,688 ft, advance—140 ft per month or 4.65 cu yd per shaftman shift—single unit mucked about 11 cu yd per hr. (*CMM* Bulletin, April 1955).

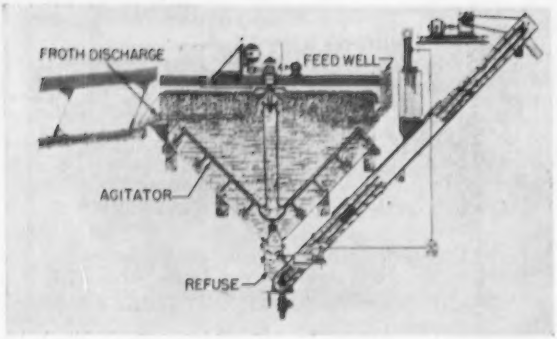
Clamshell bucket rigidly attached to rotatable extensible arm (Fig. 15), offered in U. S. by Shaft & Development Machines Co., is operated by air cylinders. Although rated at 40 tons per hour a contractor deepening a 12x18-ft vertical shaft below 1,000 ft got 13 cu yd per mucking man shift. (*CMM* Bulletin, October 1955). On a 6½x16-ft vertical it was over 40 cu yd per hr with three men. And with two units on a 10x35-ft, 61-deg incline it was near 50 cu yd per machine hour. (*MCJ*, March 1957).

Overcast mucker has worked in both inclined and vertical shafts too. Two rail-type units on ropes mucked 7 cu yd per machine hour in 8x12-ft, 26-deg incline below 1,000 ft, for 120-ft advance per month. (*E&MJ*, October 1952). One was also used in vertical shaft. (*E&MJ*, May 1949). A crawler unit (Fig. 16) in a 20-ft dia vertical shaft mucked about 15 cu yd per hr. (*ME*, December 1956).

15. Clamshell arm—Cryderman

16. Overcast loader—Eimco Corp.

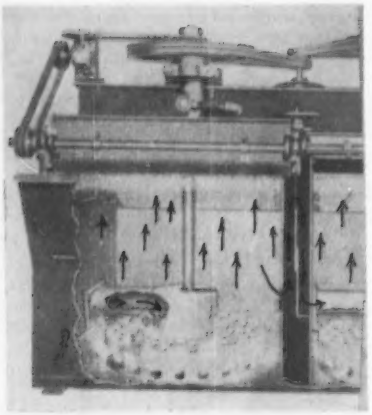
Size Data on Some



Wilmot—Wilmot Engineering Co.*

Diameter of unit	Feed (tph)	Clean coal capacity, tph — No. 5 coal	No. 5 froth	Horsepower — Agitator	Pump
6 ft	12	3	6	2	5
9 ft	26	6	12	2	7.5
12 ft	45	10	20	3	10
16 ft	80	20	35	3	15

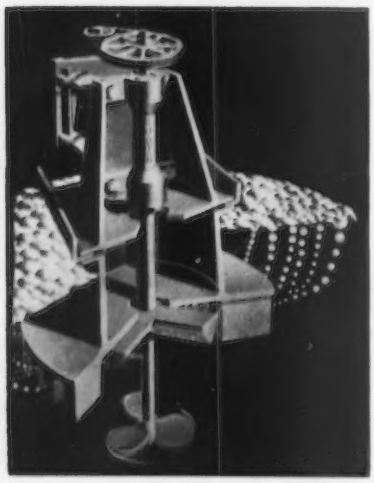
*Clean coal capacities are minimum figures. Horsepower figure for screens refers to each screen. 6-and 9-ft units have one screen; 12-ft has two and 16-ft has three.



Jetair—Morse Brothers Machinery Co.*

Unit number	Cell size	Volume cu ft	Hp per cell	Approximate dry tons per 24 hr — 4-cell	6-cell	8-cell	10-cell
7	22x22-in.	7	0.9	20–35	30–35	40–55	—
11	25x25-in.	11	1.2	30–55	40–75	60–100	—
16	29x29-in.	16	1.5	45–80	65–115	90–160	110–190
22	32x32-in.	22	2.3	60–110	90–160	120–220	150–270
30	36x36-in.	30	2.7	75–135	120–220	160–290	195–350
40	40x40-in.	40	3.2	100–190	160–280	210–375	250–450
50	43x43-in.	50	4.2	125–225	190–350	250–450	310–560
60	47x47-in.	60	4.5	150–270	230–420	300–540	375–675
100	58x58-in.	100	9.0	250–450	400–750	525–900	650-1,150

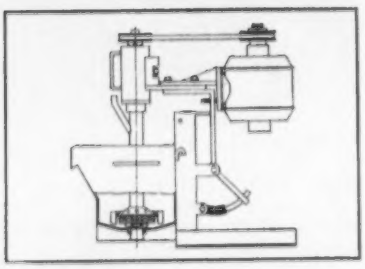
*Capacity ratings are for approximations only. They vary according to the character of the ore. Tonnages here are based on slow (first figure) and medium (second figure) floating ores at 25% solids. Hp is based on 2.7 specific gravity feed at 20 to 25% solids at normal impeller speeds.



Booth Machine—Booth Co., Inc.*

Cell size	Capacity in dry tons solids per 24 hr — 4 cells	6 cells	8 cells	10 cells	12 cells
18x24-in.	15	23	31	39	47
24x32-in.	40	60	80	101	121
36x44-in.	102	153	204	255	306
44x56-in.	180	269	366	448	570
56x68-in.	345	518	691	864	1,036
66x78-in.	546	805	1,070	1,395	1,615
72x84-in.	740	982	1,480	1,850	2,220

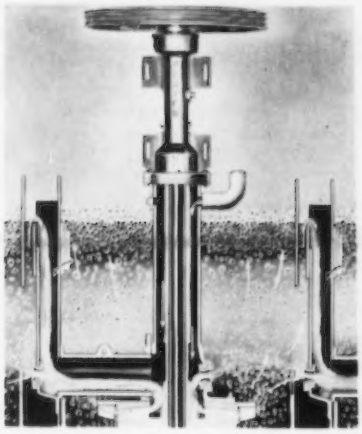
*On 2.8 specific gravity ore at 30% solids and eight minutes flotation time.



AWFCO All-Purpose Machine—A. W. Fahrenwald Co.

Unit number	Cell size	Volume cu ft	Depth of cell to overflow lip	Motor hp — One cell	Two cell
1	12x12-in.	1	12-in.	⅓	½
24	24x24-in.	12	30-in.	3	5
36	36x36-in.	25	30-in.	7.5	10
42	42x42-in.	34	30-in.	10	15
48	48x48-in.	42	30-in.	10	20

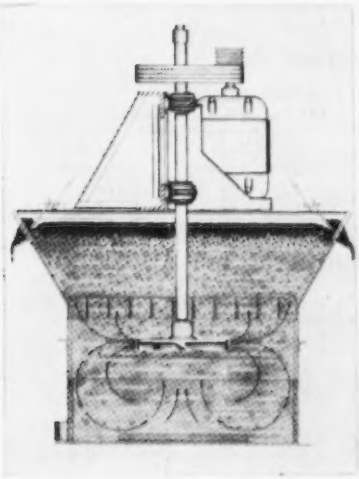
Modern Flotation Machines



Standard Sub-A—Denver Equipment Co.*

Unit number	Volume per cell, cu ft	Motor rpm	Motor hp	Width (in.)	Height (in.)	Approximate length (in.) 2-cell	4-cell	6-cell	8-cell	10-cell
8	2.75	—	1.5	16	35	44	83	122	161	200
12	10	1,800	2	22	55	64	118	172	226	280
15	12	1,800	3	25	55	70	130	190	250	310
18	18	1,800	5	27	62	76	142	218	274	340
18 Sp	24	1,800	5	31	64	86	160	235	310	385
21	40	1,800	7.5	38	78	101	189	278	367	456
24	50	1,800	10	43	78	112	212	312	412	512
30	100	1,200	20	56	98	144	273	403	532	661
18 Sp-R	18.6	1,800	3	32	58	73	138	192	268	—
21-R	30	1,800	5	38	71	84	160	237	313	—
24-R	38.4	1,800	7.5	43	71	94	181	267	1,166	—
30-R	93	1,800	10	56	97	123	236	348	461	—

*Horsepower is per two cells. Single cell motor drives can be provided on No. 18 Special and larger machines if desired.



Mineral Separation's Airflow—Franco Products Div. Frank M. Murphy & Associates*

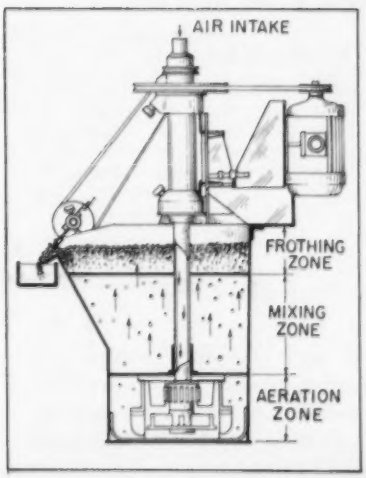
Unit number	Cell size	Volume cu ft	Approximate capacity in dry tons per 24 hr — 4-cell — Flotation time in minutes: 3	6	9	12	8-cell: 3	6	9	12
3	24-in.	12	267	133	89	67	533	267	178	133
4	30-in.	22	489	244	163	122	978	489	326	244
5	36-in.	32	711	356	237	178	1,422	711	474	356
6	42-in.	50	1,111	556	370	278	2,222	1,111	741	556
7	48-in.	68	1,511	756	504	378	3,022	1,511	1,007	756
8	54-in.	85	1,889	944	630	472	3,778	1,889	1,259	944

*Capacity is calculated on 2.7 specific gravity ore at 30% solids.

FLOTATION FACTOR*

Per cent solids	Flotation factor at various specific gravities (dry solids) 1.4	2.2	2.6	2.8	3.0	3.2	3.8	4.2	4.6
5	0.438	0.432	0.431	0.430	0.430	0.429	0.428	0.428	0.427
10	0.216	0.210	0.208	0.208	0.207	0.207	0.206	0.205	0.205
15	0.142	0.136	0.134	0.134	0.133	0.133	0.132	0.131	0.131
20	0.105	0.099	0.097	0.097	0.096	0.096	0.095	0.094	0.094
25	0.082	0.077	0.075	0.075	0.074	0.074	0.072	0.072	0.071
30	0.068	0.062	0.060	0.060	0.059	0.059	0.058	0.057	0.057
35	0.057	0.051	0.050	0.049	0.049	0.048	0.047	0.047	0.046

*Flotation factor—volume in cu ft to give one minute retention for one ton per 24 hr.

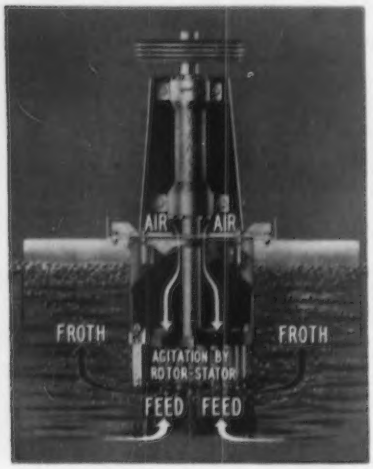


K&B Sub-A—Knapp & Bates Ltd.*

Unit size	Ratio W/S	Per cent solids	Specific gravity 2.6	3.0	3.6	4.2
23x23-in.	4 : 1	20	0.01311	0.01296	0.01279	0.01267
	3 : 1	25	0.01012	0.00997	0.00980	0.00968
	2 : 1	33	0.00722	0.00707	0.00690	0.00678
35x35-in.	4 : 1	20	0.00454	0.00449	0.00443	0.00439
	3 : 1	25	0.00350	0.00345	0.00339	0.00333
	2 : 1	33	0.00250	0.00245	0.00239	0.00235
47x47-in.	4 : 1	20	0.00192	0.00190	0.00188	0.00186
	3 : 1	25	0.00148	0.00146	0.00144	0.00143
	2 : 1	33	0.00106	0.00104	0.00101	0.00100

*To calculate number of K&B Sub-A cells required—multiply dry tons per 24 hours by flotation time in minutes by this factor.

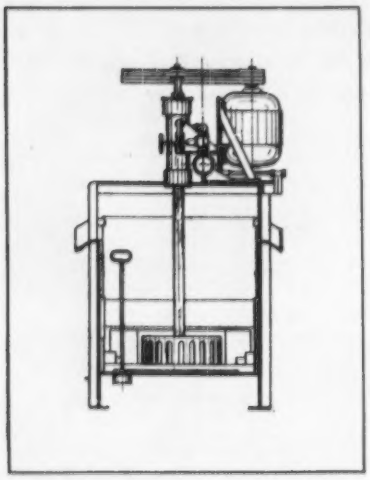
(Continued on next page)



Fagergren—Western Machinery Co.*

Cell size	Volume cu ft	Motor hp per cell	Capacity in dry tons solids per 24 hr: 4-cell, Flotation time in minutes: 4	4-cell: 8	4-cell: 12	8-cell: 4	8-cell: 8	8-cell: 12	12-cell: 4	12-cell: 8	12-cell: 12
18x18-in.	1.6	½	27	13	9	53	27	18	80	40	27
28x28-in.	5	1½	84	42	28	167	83	56	250	125	83
36x36-in.	11	3	183	92	61	367	183	122	550	275	183
44x44-in.	21	5	350	175	116	700	350	233	1,050	525	350
56x56-in.	40	10	670	330	225	1,330	665	445	2,000	1,000	667
66x66-in.	61	15	1,015	510	340	2,030	1,015	645	3,050	1,525	1,015

*Capacities are for ores having a specific gravity of 2.8 at 30% solids in pulp.

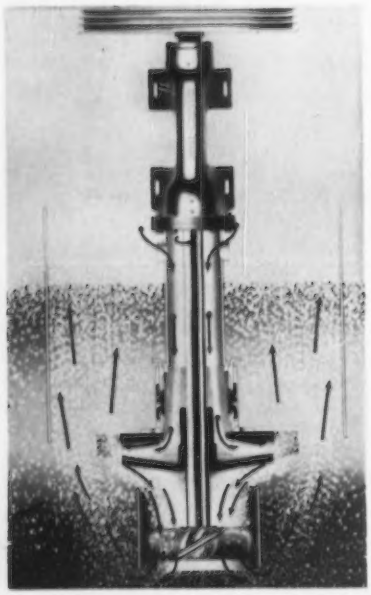


Agitair—Galigher Co.

Unit number	Froth area, sq ft per cell	Cell volume, cu ft per cell	Cells in a unit
15	1.56	1.95	2, 4 or 6
24	4.0	10.0	2, 4 or 6
36	9.0	22.5	2 or 4
48	16.0	40.0	2 only

Air Requirements per Agitair Cell at 1½ psi

Unit number	Volume of air cfm	Installed hp for air cell displacement
15	10	0.1
24	20	0.2
36	40	0.4
48	75	0.75



Denver Type-M—Denver Equipment Co.*

Cell size	Volume in cu ft	Motor rpm	Motor hp per cell	Width (in.)	Height (in.)	Approximate length (in.): 2-cell	4-cell	6-cell
32x32-in.	24	1,800	2–3	44	70	80	144	207
38x38-in.	40	1,800	3–5	50	84	93	170	246
42x42-in.	50	1,800	5–7.5	55	86	106	193	279
56x56-in.	100	1,800	7.5–10	66	90	134	247	—
72x72-in.	200	1,200	15–20	82	110	176	320	—

*Length includes feed and discharge boxes.

Check the Buyers' Guide and Directory section for further information on flotation machines and auxiliary equipment. For complete details on flotation reagents, their manufacturers and their uses, see *E&MJ* Mid-June Mining Guidebook, 1956, pp 111 to 116.

Separation Characteristics of Minerals

NON-CONDUCTORS (HIGH TENSION PINNED)				CONDUCTORS (HIGH TENSION THROWN)				
SP. G.	MAGNETIC	WEAKLY MAGNETIC	NON MAGNETIC	HIGHLY MAGNETIC	MAGNETIC	WEAKLY MAGNETIC	NON MAGNETIC	SPECIFIC GRAVITY
Over 8.0							Gold Copper	Over 8.0
8.0						Tantalite		8.0
7.5							Galena	7.5
					Ferberite	Wolframite		
7.0							Cassiterite Wulfenite	7.0
6.5								6.5
6.0			Scheelite					6.0
5.5						Samarskite		5.5
	Monazite			Magnetite[1]		Columbite Hematite Franklinite		
5.0		Bastnasite					Pyrite	5.0
						Euxenite		
			Zircon	Ilmenite— (High Iron)	Ilmenite	Chromite	Molybdenite	
4.5	Xenotime		Barite		Davidite		Koppite	4.5
							Rutile Chalcopyrite	
4.0	Garnet Siderite Staurolite		Perovskite Corundum Celestite			Ilvaite Marmatite	Brookite Sphalerite	4.0
3.5		Epidote Olivine Hornblende Apatite Tourmaline	Kyanite Diamond Topaz Sphene Sillimanite Fluorite				Acmite Augite	3.5
3.0		Mica (Biotite)	Anhydrite Mica (Muscovite) Beryl Feldspars Calcite Quartz					3.0
2.5								2.5
			Gypsum				Graphite	
			Chrysotile					
			Sulphur					
2.0								2.0
Under 2.0								Under 2.0

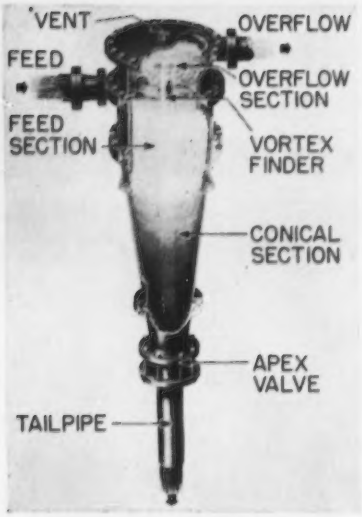
(Copyright Carpco Engineering Co.)

How to Use the Table

Starting with a mixture of any of the above minerals it may be determined whether or not they can be separated by high tension, magnetic or gravity methods and whether any one, or a combination of methods is required. If the minerals appear in different columns they may be separated by high tension and/or magnetic methods alone. Two or more minerals appearing in the same colume can be separated by gravity concentration if they have sufficient difference in gravity (usually a difference in approximately 1.0).

It should be noted that grain shape and/or size may alter separation characteristics. This is sometimes a detriment and other times useful. As an example, mica and quartz may in many cases be separated by high tension, due to their grain shape.

Minerals behavior characteristics shown are from tests made in Carpco's laboratories rather than theoretical. Mineral characteristics and behaviors sometimes vary from different deposits. The behavior of minerals not shown can usually be predicted by the behavior of similar minerals in the above table.



(Courtesy Dorr-Oliver Inc.)
NOMENCLATURE explains cyclone parts that affect final operating results.

(Courtesy Dorr-Oliver Inc.)
CYCLONES are being used to deslime, concentrate, dewater and classify.

(Courtesy Equipment Engineers Inc.)
ORE characteristics limit what the cyclone can do regardless of size.

How To Get the Most Out of a

WET CYCLONES have definite advantages over mechanical and gravity classifiers—space saving, high efficiency, very high capacity for their small size and low initial cost. For example, a single 24-in. dia cyclone can make a 134 micron cut on mine backfill at the rate of 40 tph. Closed circuit grinding and sizing installations are in operation that remove up to 99% of the slime. In addition, capital cost including the pump, will be only 20 to 50% of that for a conventional classifier.

Cyclones can be placed in parallel to give high tonnage throughput or they can be staged in series to make exceptionally fine and clear-cut separations. They're being used to deslime, degrit, classify, concentrate, make dam and mine backfill and even to dewater or thicken where the overflow can be returned to the process or can be discarded.

The actual cut or separation made will depend on the specific gravity of the pulp and its concentration, but the following additional variables exist and can be controlled to some extent to get the most out of the wet cyclone. These variables can be broken down into three categories: limiting variables in the ore, controlling variables in cyclone design, and routine operating variables.

First let's consider the limiting effects caused by the ore itself and then we'll move on to cyclone design, cyclone operation and wind up with plenty of performance examples.

How the Ore Affects Cyclone Performance

Volume of the pulp, its critical size distribution and viscosity limit what can be done in the cyclone as follows:

Volume of the pulp has nothing to do with the size of the cyclone needed. Size of the cyclone depends only on the mesh of separation desired. Since in most cases where cyclones are being installed the volume of the pulp is already set, it is important that fluctuations in volume be avoided if possible, since these fluctuations will alter conditions for which the vortex finder and apex valve have been set.

If these changes are slow and minor, manual or hydraulic operation of the apex valve will be sufficient. But if feed surges are large or irregular and cannot be controlled with a surge bin ahead of the cyclone, an automatic regulating vortex-vacuum finder should be installed.

For best results and uniform abrasion rates in all cyclones, it's a good idea to put several cyclones in parallel and distribute the feed evenly among them; keeping one cyclone as a spare. Run this spare cyclone in the line to replace each of the others in turn. This will help to keep abrasion rates similar in all the operating units.

Critical size distribution in the pulp after grinding to liberation can affect cyclone operation in many ways. For example:

The more coarse particles present in the pulp, the coarser will be the cut or mesh of separation, regardless of the cyclone diameter. Two examples given by Fitch and Johnson[1] point this out.

1. A 3-in. dia DorrClone cut at 23 microns on minus 65 mesh feed; but the same 3-in. unit cut at 16 microns on minus 325 mesh feed.
2. A 12-in. dia DorrClone cut at 36 microns on minus 65 mesh feed; and at 29 microns on minus 325 mesh.

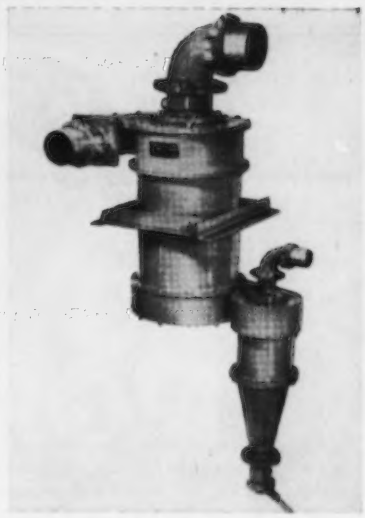
Scalping out the coarse sizes ahead of the cyclone will make a finer cut possible. This can be done by combining a classifier with the cyclone so that the cyclone treats the classifier overflow, or by using integrated, two-stage cyclones.

If the feed contains much clay (more than 2 or 3%), the separation will be somewhat coarser than if the clay were absent. High clay content can be counteracted to some extent by increasing the feed pressure.

If there is much 65 to 100 mesh material in the pulp, the feed inlet position and its orientation become very important. Cyclone manufacturers have experimented a great deal to determine the most likely conditions and positions of the inlet for various size-distribution categories.

If you're interested in using the cyclone to concentrate the ore, try using the fines already present as an

(Courtesy Heyl & Paterson Inc.)
DESIGN of the cyclone permits the operator to predict final results.



(Courtesy Equipment Engineers Inc.)
CONTROLLING the variables in the pulp makes it possible to duplicate results.

How to Make the Cut As Fine as Possible

1. Use small diameter cyclone.
2. Use long cylindrical section.
3. Use a long conical section.
4. Use a small vortex and feed inlet diameter.
5. Keep the pulp dilute.
6. Keep the pressure high.
7. Keep the underflow dilute.

Wet Cyclone

absolute gravity medium. Dutch State Mines uses this idea to upgrade coal, using the fine shale already present as a medium.

Solid-solid absolute gravity separations with magnetic medium can be accomplished on ore down to about 65 mesh.

Coarse feed tends to increase abrasion rates, particularly in the pump. At Patrick Mine, Minn., an 800 tph cyclone plant was installed in 1954. Rubber liners in the cyclones were expected to last about three months on this coarse feed. However they were still in operation in 1957.

Specific gravity limits separation as follows:

Cyclone dia in.	Separation mesh Sp gr 1.35	Sp gr 2.7	Sp gr 4.0
3	50 to 85	23 to 40	17 to 30
24	115 to 150	52 to 67	40 to 50

The heavier the feed, the finer the mesh of separation can be, regardless of the cyclone diameter.

Pulp viscosity affects separation in that the more viscous the pulp, the coarser the separation; and the more tramp oversize that will occur in the overflow; and the more the fines that will stay in the underflow. Remember that clay content over 2% will tend to give a coarser separation. Use high feed pressure and small cyclone diameter to overcome high viscosity.

How Cyclone Design Affects Performance

Size and shape of various parts of the cyclone affect the results obtained as follows:

Cone and cylindrical section. Increasing the inclined angle of the cone (shortening the cone) will decrease feed capacity and increase overflow density. The shorter the cone section, the less chance for the apex to plug.

Increasing the height of the cylindrical section tends to reduce capacity and to decrease the volume and density of the underflow.

Cyclone diameter. The smaller the cyclone diameter, the finer the cut down to the 5 to 20 micron range. Use large diameter cyclones for coarse cuts.

Diameter of the cyclone influences capacity as shown below.

Krebs cyclones have the following general capacities:

Cyclone dia in.	Gpm range	Tph maximum
4	20 to 60	5
10	120 to 300	50
20	300 to 1000	100
30	750 to 2500	500

Feed entrance and vortex finder diameter. The smaller the feed opening, the finer the cut that can be made. The smaller the vortex finder diameter, the finer the cut. These two rules apply only down to a certain minimum diameter, after which the product in the overflow will become coarser. Generally speaking, the combined area of the vortex finder and feed inlet should be 1/5 to 1/6 of the cyclone's cross-sectional area.

The angle at which the inlet enters the cyclone is important if the pulp contains much 65 to 100 mesh material.

The length of the vortex finder is unimportant until it enters the zone of the cylindrical section.

Apex valve determines the per cent solids in the underflow. Closing down on the valve increases the underflow solids density and makes the mesh of separation coarser. If the apex opening is kept too small, it will throw tramp oversize into the overflow.

Keeping the underflow as dense as possible will weed out the fines and make it possible to get a cleaner underflow; but the recovery will drop as more material will be thrown into the overflow.

The apex is the most critical part of the cyclone. It can be controlled manually or hydraulically or with a completely automatic device that measures the vacuum in the vortex and adjusts the apex accordingly. Dorr-Oliver makes the Vactrol automatic regulator and Equipment Engineers makes a Krebs Series S hydraulic-operated valve.

Ropey underflow means that the apex is overloaded. Use this ropey discharge if you're making dam or mine backfill. Allow the underflow to spray out, just short of being ropey, for the cleanest possible separation.

(Continued on page 88)

(Courtesy Liquid-Solid Separations Ltd.)

LABORATORY test cyclones are readily available.

(Courtesy Dorr-Oliver Inc.)

CYCLONES, 50-mm dia, can make cuts at 15 microns.

(Courtesy Dorr-Oliver Inc.)

UNIT-TYPE cyclones, are rubber lined in fixed openings.

(Courtesy Dorr-Oliver Inc.)

CYCLONES are available in singles, doubles, or multiples.

How Operating Variables Affect Performance

Per cent solids of the pulp and feed pressure affect the accuracy of the cut, the mesh of separation, and the distribution of critical sizes as we shall see below.

Per cent solids of the pulp affects capacity, overflow and underflow density and the mesh of separation. According to Fitch and Johnson[2], the water-to-feed-solids ratio should be about 8:1, or about 25% solids on pulp with 2.7 specific gravity. These two authors determined the effect of per cent solids on mesh of separation, using a 12-in. dia DorrClone. The volume of dilution is the liquid volume divided by the solids volume.

Volume of dilution	Per cent solids in overflow	Separation
4	42	plus 100 mesh
5	37	60 micron
6	32	43 micron
8		
10	22	36 micron
20	13	32 micron
Very high	Very low	29 micron

Feed pressure. Increasing the feed pressure tends to give a finer cut, but also a poorer separation mesh and a higher underflow density. Decreasing the feed pressure has the opposite effects. Raising the feed pressure will boost throughput, but calls for higher pumping costs and higher abrasion rates. Generally, cyclones are operated in the 10- to 50-psi range. There is no reason why higher pressures cannot be used, except that pumping costs will get out of hand.

Increasing the pressure changes the average diameter of the separation. This average diameter seems to vary inversely as the fourth root of the pressure; doubling the pressure will afford a 16% decrease in average diameter of separation.

In closed circuit grinding only 2 to 12 psi are needed, but the finer overflows than normal require higher pressures. At Erie Taconite, pressure is held at 17 to 21 psi by adding or taking off a cyclone as necessary to maintain this pressure. The spare cyclone is alternated with each of the production units in turn to keep abrasion rates equal in all cyclones.

Back pressure at the overflow will reduce capacity and increase the underflow density. At Lebanon Concentrator, Bethlehem Steel Co., vacuum is maintained in the cyclones by discharging the overflow into a submerged receiving box. Vacuum probe is used to control the overflow volume and the underflow density.

Accuracy of the cut depends on how high you keep the per cent solids in the underflow. Crowd the apex as much as possible and crowd out the fines that fill the voids. Keep the underflow ropey or just short of ropey for best desliming, for making dam or mine backfill and for thickening. Allow the underflow to spray for a coarse cut at the overflow.

Size at separation is mainly a function of cyclone diameter. The smaller the desired micron of separation, the smaller the cyclone diameter will have to be. Here are the general size ranges and their separation.

Diameter (in.)	Separatio) (micronsn
10 to 15mm	2 to 20
3	5 to 20
10	100 to 150
24	very coarse

Dorr-Oliver Inc. reports the following data on their 3-in. DoorClone on minus 65 mesh dolomite:

Feed entrance (sq in.)	Vortex finder (dia in.)	Separation (microns)
0.75	1.05	34
0.53	0.82	28
0.30	0.62	24
0.19	0.62	23
0.10	0.36	27

Heyl & Paterson cyclones will make the following cuts:

Diameter (in.)	Gpm	Psi	Separation (microns)
3	10	40	5 to 20
8	100	30	20 to 40
14	230	30	100 to 150
24	1,000	20	very coarse

Dorr-Oliver Inc. reports the following data on the DorrClone on minus 65 mesh feed at 50-ft head. Note how size depends on specific gravity.

Diameter (in.)	Gpm range	Separation range Sp gr 1.35	Sp gr 2.7	Sp gr 4.0
3	8–46	50–85	23–40	17–30
6	43–152	62–100	28–45	21–33
12	160–550	82–128	37–58	28–44
24	465–1,460	115–150	52–67	40–50

Distribution of sizes in the two products (overflow and underflow) depends on these four factors.

1. Per cent solids in the underflow is determined by the apex valve set-

ting. If the per cent solids is kept too high, it will throw tramp oversize into the overflow; but will have little effect on the underflow sizes, and a lower underflow recovery will result.

2. Size of feed entrance and vortex finder determine the mesh of separation. Decreasing the feed and vortex finder diameter tends to give a poorer cut and a higher underflow recovery.

3. Size of the cyclone diameter determines how coarse or fine the cutting range can be. Choose your cyclone for mesh separation desired; not for capacity. Get capacity by using as many cyclones as needed.

4. Increasing the feed pressure tends to throw more material into the overflow, making for a poorer separation and a finer overflow. To use a cyclone as a thickener, use a small diameter unit, with small feed, vortex and apex openings and keep the feed pressure as high as possible and the pulp as dilute as possible.

Operating and maintenance costs. According to Lewis and Johnson,[3] the following comparative cost data was obtained in conjunction with a 24-in. DorrClone installation at Tennessee Copper Co., Copperhill, Tenn.

Pump maintenance	Cost per day
Impellers, suction and gland side liners and casing plate	$2.24
Labor	0.04
DorrClone vortex, head and cone and apex valve	0.41
Power (0.44c kwh)	0.83
Total	$3.52

This operating cost to close a ball mill with a 24-in. cyclone was about twice the cost of that for the original bowl classifier replaced. To be exact—$3.52 for the cyclone as against $1.92 for the bowl. The cyclone handled 497 gpm at 50.6% solids on 5 psi. Vortex life was about 100 to 150 days. Feed and conical section life was estimated at 3 years. The apex valve showed no sign of wear during the period described. It might be pointed out here that a lot has been learned on how to combat abrasion by cyclone manufacturers since this installation. New materials of construction have been tested and developed to reduce wear in the cyclone.

At Tennessee Copper, the cyclone overflowed at 40.9% solids with 83% minus 200 mesh. With the change to the cyclone, tonnage on this circuit went up from 104 to 177, while ball mill hp dropped from 155 to 131.

The 24-in. dia cyclone has a 20-deg cone angle, 8-in. dia vortex finder, 20-sq in. feed inlet area and a maximum 6-in. dia apex valve.

Recommended pump sizes for a 24-in. DorrClone*

Pump size (in.)	Operating head (ft)	Pressure psi	Gpm	Hp	Rpm
With 5-in. dia vortex-finder and 2- to 3-in. dia apex valve					
5	30	14	650	20	950
5	40	18	750	20	860
5	50	22	850	25	800
With 10-in. dia vortex finder and 3- to 4-in. dia apex valve					
6	30	14	1,150	20	860
6	40	18	1,350	30	880
6	50	22	1,450	40	900

*According to Smith Engineering Works.

At Erie Taconite, where the ore is among the world's toughest and most abrasive, it appears that for minus ⅛-in. feed that thick rubber or Linatex will out wear ordinary Ni-Hard, according to Herkenhoff[4]. Carborundum apex disks presently show superior wear-life to either rubber or chilled Ni-Hard. Ni-Hard feed nozzles wear as well as rubber at Erie. Strangely enough, there is considerably less wear with circular nozzles than with rectangular ones.

Feed inlet sections with ¾-in. rubber liners appear to have a wear-life of about eight months (during which time each 14-in. dia cyclone handled 300,000 tons of actual feed or the equivalent of 75,000 tons of new feed). Ni-Hard apex disks lasted about two months. Certain silicon carbide apexes show considerable promise, according to Herkenhoff.

Still according to Herkenhoff, the following wear rates occurred on the 8x6-in. SRL-C rubber-lined pumps feeding to the cyclones. Each pump draws about 55 hp and operates at 930 rpm.

Part	Life in months	Tons handled
Impeller (closed)	2 to 3	600,000
Casing plate	3 to 4	700,000
Gland side liner	4	800,000
Suction side liner	6	1,200,000

Herkenhoff notes that in the lean ore plants on the Mesabi, Ni-Hard is the preferred cyclone liner. Also that all Ni-Hard-lined Wilfley and Wemco 8x6-in. sand pumps are used with wear rates as follows:

Pump parts	Tons treated
Impellers	45,000
Follower plates	17,000
Casing	90,000

Many different sizes, shapes and designs of cyclones are available, from single units with 10- to 15-mm dia on up to 24-in. dia; multiple units from 10- to 30-mm dia; and integrated two-stage units from 3- to 24-in. dia.

In addition, it is possible to buy manual, hydraulic and automatic apex valves.

Bibliography

1. Operating Behavior of the Liquid-Solid Cyclone, E. B. Fitch and E. C. Johnson, *AIME*, 1952.
2. Same as 1.
3. The Liquid-Solid Cyclone as a Classifier in Closed Circuit Grinding of Concentrates, F. M. Lewis and E. C. Johnson, *AIME*, 1954.
4. Control of Cyclone and Cyclone System, E. C. Herkenhoff, American Mining Congress Paper, 1955.
5. Fundamentals and Applications of the Liquid Cyclone, D. A. Dahlstrom, *AIChE*, 1953.
6. Fontein and Dyksman, *IMM*, Paper No. 18, 1952.
7. Same as 6.
8. Same as 5.
9. Same as 5.
10. Same as 5.
11. Same as 5.
12. Metallurgical Application of the DorrClone, F. T. Weems, *AIME*, 1951.
13. Cyclone Symposium, T. M. Morris, *AIME*, 1957.
14. Same as 13.
15. Same as 13.
16. Same as 13.
17. Same as 13.
18. Same as 13.
19. Application of the Liquid-Solid Cyclone as a Classifier in Closed Circuit Grinding at the Morenci Concentrator, L. M. Barker, J. F. Papin and R. C. Barr, American Mining Congress, 1955.
20. Cyclones in Closed Circuit Grinding, R. W. Krebs, *AIME*, 1956.
21. Same as 20.

Acknowledgment

This article and the case histories listed on the following two pages are through the kind cooperation of Dorr-Oliver Inc., Heyl & Paterson, Inc., Equipment Engineers Inc., Smith Engineering Works, Liquid-Solid Separations Ltd., Wilmot Engineering and Peterson Filter & Engineering Co. For further information as to the types of cyclones and auxiliaries each manufacture makes, use the Buyers' Guide section of the Guidebook to locate the proper address and write to the companies for details.

How Cyclones Perform—

Case Histories from the Mining Industry

CYCLONES are being used to degrit, deslime, classify and, concentrate minerals such as phosphate, clay, coal, sand, gravel, lead, magnetite, iron ore, magnesite, etc. We've included as many case histories as possible to show what the cyclone can do. If you're considering the wet cyclone for your mill, this record of performance may give you an idea of what to expect from a cyclone on your ore or concentrate.

Degritting drill flushing mud at Dutch State Mines in four 4-in. cyclones on 29 psi.[6]

	Feed	Over-flow	Under-flow
Gpm	163	135	28
Specific gravity	1.23	1.18	1.48
Per cent solids plus 256 mesh	15.5	0.51	42

Separating lead ore, 0.5 to 4mm, in a cyclone with magnetite media at 2.1 specific gravity.[7]

	Feed	Over-flow	Under-flow
Per cent Pb	1.7	0.17	20.85
Weight per cent of feed	100	92.6	7.4
Per cent Pb recovered	....	....	90.7

Cycloning phosphate in a 24-in. unit at 14 psi, 14% solids, 40% minus 200 mesh at 32 tph on 794 gpm.[8]

	Overflow	Underflow
Per cent minus 200 mesh	95.5	6.5
Gpm	723	71
Per cent solids	....	70
Per cent plus 200 mesh	....	87
Per cent rejection minus 200 in underflow	....	89.3

Dewatering pyrite concentrate in a 3-in. cyclone at 15.5 psi, 20.7% solids, 50% minus 200 mesh at 1.95 tph on 32 gpm.[9]

	Overflow	Underflow
Per cent minus 200 mesh	98.65	41.4
Gpm	28.2	3.9
Per cent solids	3.98	47
Per cent plus 200 mesh recovered	....	98.5
Per cent minus 200 mesh rejected	29.5	....

Treating phosphate in ten 48-in. cyclones at 18 psi, 9,000 to 9,500 gpm at 20% solids, 31.7% minus 200 mesh.[12]

Per cent of feed recovered in underflow	74.5
Per cent solids in the underflow	47
Per cent recovery of phosphate	98.9

Closed circuit grinding with one 20-in. to each primary mill and two 20-in. to each secondary mill. Feed was at 55 to 60% solids, 11 psi, with a 5¼-in. dia vortex diameter.

Overflow, per cent minus 200 mesh	88
Overflow, per cent solids	34
Per cent plus 100 mesh in overflow	trace

Closed circuit grinding with Krebs Model D20B cyclone at 55 tph new feed, 200% circulating load, 13 psi and 19 hp on each cyclone.

	Per cent in overflow
Per cent solids	37
Plus 100 mesh	0.2
Plus 150 mesh	4
Plus 200 mesh	8.2
Minus 200 mesh	87.6

Two-stage cycloning in 10 Krebs Integral cyclones at 5,840 gpm, 281 tph, with primary overflow rejecting slimes and secondary overflow rejecting low-iron fine sand. Feed assayed 20.75% Fe. Underflow runs 34.72% F.[20]

	Underflow
Tph	108
Per cent solids	72.8
Size distribution in per cent	
Plus 48 mesh	12.5
Plus 100 mesh	34.5
Plus 200 mesh	18.3
Plus 325 mesh	17.5
Minus 325 mesh	17.2

Recycling the critical sizes from the secondary overflow from the Krebs cyclone above back into the primary cyclone feed.[21]

	Feed	Over-flow	Under-flow
Tph	75	31	44
Gpm	968	825	143
Per cent solids	26	13.7	70
Size distribution in per cent			
Plus 35 mesh	0.4	....	0.7
Plus 48 mesh	2.3	....	3.9
Plus 65 mesh	17.1	....	29.2
Plus 100 mesh	28.9	....	49.2
Plus 200 mesh	10.0	2.3	15.5
Minus 200 mesh	41.3	97.7	1.5

Desliming and classifying sand at Dravo Corp.'s Wellsville, Ohio, plant, using Heyl & Patterson, Inc.'s 14-in. cyclone on 40 psi.

	Feed	Over-flow	Under-flow
Gpm	490	483	7
Per cent solids	2.5	0.4	72.6
Size distribution in per cent			
Plus 32 mesh	1	....	2
Plus 60 mesh	7	....	9
Plus 100 mesh	15	....	24
Plus 200 mesh	32	1	34
Plus 325 mesh	22	2	20
Minus 325 mesh	23	97	11

Desliming coal ahead of tabling with Heyl & Patterson, Inc.'s 14-in. cyclones at Harmar Coal Co., Harmarville, Pa., on 35 psi.

	Feed	Over-flow	Under-flow
Gpm	250	236	14
Per cent solids	10.6	7.9	53.8
Size distribution in per cent			
Plus 16 mesh	0.1	....	1.4
Plus 32 mesh	0.5	....	2.4
Plus 60 mesh	4.4	....	18.4
Plus 100 mesh	7.4	0.4	31
Plus 200 mesh	14.3	6.5	26.3
Plus 325 mesh	8	7.6	6.8
Minus 325 mesh	65.3	85.5	13.7

Concentrating the coal slimes overflow from the Heyl & Patterson, Inc.'s 14-in. cyclone above in a Heyl & Patterson, Inc. 3-in. unit at 40 psi.

	Feed	Over-flow	Under-flow
Gpm	220	200	20
Per cent solids	7.9	5.4	25.1
Size distribution in per cent			
Plus 60 mesh	....	....	....
Plus 100 mesh	0.4	0.1	1.2
Plus 200 mesh	6.5	0.6	20.3
Plus 325 mesh	7.6	1.3	20.2
Minus 325 mesh	85.5	98	58.3

Classifying taconite at 325 mesh with Heyl & Patterson, Inc.'s 14-in. cyclones at Reserve Mining Co., Babbitt, Minn., at 15 psi.

	Feed	Over-flow	Under-flow
Gpm	395	311	84
Per cent solids	36.8	14.7	78.3
Size distribution in per cent			
Plus 16 mesh	1	....	2
Plus 32 mesh	3	....	6
Plus 60 mesh	9	....	16
Plus 100 mesh	12	....	19
Plus 200 mesh	28	6	31
Plus 325 mesh	19	13	17
Minus 325 mesh	28	81	9

Classifying at 25 microns on a 3.3 specific gravity solids in Heyl & Patterson, Inc.'s 8-in. cyclone at Carborundum Co., Niagara Falls, N. Y., at 20 psi.

	Feed	Over-flow	Under-flow
Gpm	87	83	4
Per cent solids	1.15	0.52	13.5
Size distribution in per cent			
Minus 10 microns	23	45	2
Minus 20 microns	13	25	3
Minus 40 microns	31	26	39
Minus 60 microns	23	3	36
Minus 100 microns	7	1	13
Plus 100 and minus 300 microns	3	....	7

Desliming Florida pebble phosphate in Dorr-Oliver Inc.'s 24-in. DorrClone, fitted with an automatic (RA-type) apex valve of nominal opening at 4-in. and an 8-in. dia vortex finder. Data is average of seven runs at 8.4, 19.4, 15.4, 19.8, 23, 21.4 and 32.6% solids on feed pressure of 18 psi.[13]

	Feed	Over-flow	Under-flow
Per cent solids	20	6.5	47.8
Size distribution in per cent			
Plus 20 mesh	2.5	....	3.9
Plus 28 mesh	5.2	....	8.6
Plus 35 mesh	11.5	0.2	15.1
Plus 48 mesh	22	0.4	27.2
Plus 65 mesh	36.8	1.1	46.7
Plus 100 mesh	58.3	2.7	77.4
Plus 150 mesh	65.5	3.4	85.3
Plus 200 mesh	68.3	4.1	89.8
Minus 200 mesh	31.7	95.9	10.2
Plus 200 mesh recovered	....	....	98.9
Minus 200 mesh rejected	....	74.5	....

Same 24-in. DorrClone with 50% smaller feed entrance, 6-in. vortex finder and 14 psi.[14]

	Feed	Over-flow	Under-flow
Gpm	742	675	67
Per cent solids	14.2	5.5	72.8
Size distribution in per cent			
Plus 20 mesh	2.3	nil	8.2
Plus 28 mesh	5.8	nil	16.3
Plus 35 mesh	11.4	0.18	26.4
Plus 48 mesh	22.6	0.45	43.1
Plus 65 mesh	39.9	0.89	65.6
Plus 100 mesh	53.0	1.69	81.9
Plus 150 mesh	60.2	3.11	89.5
Plus 200 mesh	66.1	6.38	95.3
Minus 200 mesh	33.9	93.62	4.7
Plus 200 mesh recovered	....	....	96.8
Minus 200 mesh rejected	....	90.6	....

Desliming a 3.2 specific gravity iron ore feed with 6-in. DorrClone using 1-in. vortex finder and 0.6-in. apex dia on 35 psi.[15]

	Feed	Over-flow	Under-flow
Gpm	56.6	47.1	9.5
Per cent solids	24	2.05	75

Desliming a 2.8 specific gravity magnesite ore in 3-in. DorrClone at 40 psi with 0.5-in. vortex finder and 7/16-in. apex valve.[16]

	Feed	Over-flow	Under-flow
Gpm	15.2	11.6	3.6
Per cent solids	30.6	4.21	75.7

Dewatering and desliming mine backfill in a 24-in. DorrClone at 34 psi with 2½-in. vortex finder.[17]

	Feed	Over-flow	Under-flow
Gpm	286	....	....
Per cent solids	42.3	20.5	67.5
Tph	41	10.8	30.2
Size distribution in per cent			
Plus 65 mesh	7	....	8.4
Plus 100 mesh	21.1	0.7	25.7
Plus 200 mesh	52.7	12.7	62.5
Plus 325 mesh	69.6	30.6	78.6
Minus 325 mesh	30.4	69.4	21.4
Recovery in underflow	....	....	74.1

Desliming tailings for mine backfill in 24-in. DorrClone at 26 tph feed and 42.5 psi.

	Feed	Over-flow	Under-flow
Per cent solids	25.5	5.0	63.3
Size distribution in per cent			
Plus 65 mesh	3.8	....	4.3
Plus 100 mesh	10.7	....	12.9
Plus 200 mesh	28.8	....	35.2
Plus 325 mesh	17.5	1.4	20.5
Minus 325 mesh	39.2	98.6	27.1
Recovery in underflow	....	....	87.2

Closing the circuit on a 10x10-ft primary ball mill with a 3-in. cyclone at Morenci. Cyclone was fitted with a 20 deg cone angle, 10-in. inlet and 8-in. dia vortex finder, 12-in. dia overflow and 5- to 6¼-in. dia underflow. New feed is at 1,830 tpd at 2% plus 200 mesh.[18]

	Cyclone feed	Over-flow	Under-flow
Tpd	10,980	1,830	9,150
Per cent solids	59.1	27	78
Gpm	1,910	935	975
Per cent plus 200 mesh	9.4	17.7	9.7

Classifying manganese ore at Manganese Inc. using eight 12-in. dia cyclones. Four cyclones close a 7x10-ft rod mill with a 76-in. spiral classifier. Feed to each cyclone is at 6 psi at 250 gpm. Approximately 92% of the overflow is minus 65 mesh.[19]

	Per cent
Minus 325 in feed	34.9
Minus 325 mesh in underflow	11.3
Minus 325 mesh in overflow	50.4

Using a cyclone to thicken manganese flotation concentrate that contains up to 400 lb of flotation reagent oils per ton at Manganese Inc. Eight 12-in. cyclones handle the concentrate; two each to a 10-leaf, 8-ft 6-in. Oliver filter. Feed to the cyclones is 28% solids all minus 65 mesh, with 20- to 40% minus 10 microns. Underflow goes to the filters and overflow to a thickener. Thickener underflow returns to cyclone feed.[12]

	Per cent
Feed solids	28
Underflow solids	36
Overflow solids	20

Classifying in a regrind circuit to obtain minus 200 mesh overflow at 25% solids in the regrind circuit, using Krebs Model D10B at 22 psi.

	Feed	Over-flow	Under-flow
Gpm	270	226	44
Tph	36	16	20
Per cent solids	38	24.5	78
Size distribution in per cent			
Plus 65 mesh	5.7	....	10.2
Plus 100 mesh	9.8	....	18.0
Plus 150 mesh	12.1	....	21.8
Plus 200 mesh	10.2	1.3	17.0
Minus 200 mesh	62.2	98.7	33

Classifying 1,000 tpd tailings in four Krebs Model EE104B cyclones at 21 psi with intent to reject the minus 325 mesh.

	Feed	Over-flow	Under-flow
Gpm	769	708	61
Tph	42	23	19
Per cent solids	19	12	70
Size distribution in per cent			
Plus 65 mesh	1.8	....	4.1
Plus 100 mesh	6.2	....	13.8
Plus 150 mesh	9.5	....	20.9
Plus 200 mesh	7.6	....	17.1
Plus 325 mesh	12.4	....	26.5
Minus 325 mesh	62.5	99.2	17.6

Closed circuit grinding. Krebs 20-in. dia cyclone closing a 6x12-ft rod mill grinding for flotation feed at 28 mesh. Control data is 3 psi, 4-in. dia inlet, 7-in. dia vortex finder and 2½-in. dia apex valve.[13]

	Feed	Over-flow	Under-flow
Gpm	278	136	142
Tph	84	24	60
Per cent solids	60	45	78
Size distribution in per cent			
Plus 28 mesh	22.5	3.5	30.4
Plus 35 mesh	20.5	10.3	24.3
Plus 48 mesh	17.9	15.5	19.1
Plus 65 mesh	11.4	12.2	10.9
Plus 100 mesh	7.3	10.9	5.9
Plus 200 mesh	8.9	18.9	5.1
Plus 200 mesh	11.5	28.7	4.3

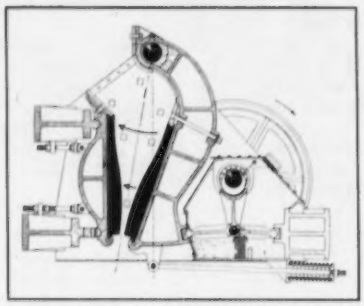
Crushers—Types, Sizes and Capacities

Jaw Crushers

Blake Type Jaw Crushers**

Size (in.)	Approximate capacity in tons per hour of 100 lb per cu ft feed — Jaw setting (in.) 1	1.5	2	2.5	3	4	5	6	9	10	12
8 x 12	5	8	10	...	...	...	...	...	...	...	...
10 x 7	6	9	13	...	...	...	...	...	...	...	...
10 x 16	11	16	20	...	...	...	...	...	...	...	...
10 x 20	14	20	25	34	...	...	...	...	...	...	...
12 x 5	12	17	24	...	...	...	...	...	...	...	...
12 x 7	10	15	21	...	...	...	...	...	...	...	...
15 x 9	10	15	21	...	...	...	...	...	...	...	...
15 x 24	...	27	34	42	50	...	...	...	...	...	...
15 x 30	...	33	43	53	62	...	...	...	...	...	...
16 x 6	18	23	30	...	...	...	...	...	...	...	...
16 x 9	15	19	25	...	...	...	...	...	...	...	...
16 x 10	8	10	12	15	...	...	...	...	...	...	...
18 x 14	...	15	20	25	...	...	...	...	...	...	...
18 x 16	...	...	...	...	30	40	...	...	...	...	...
18 x 36	...	46	61	77	93	125	...	...	...	...	...
20 x 6	6	8	10	...	...	...	...	...	...	...	...
20 x 10	...	12	16	20	36	...	...	...	...	...	...
24 x 8	30	40	49	...	...	...	...	...	...	...	...
24 x 10	28	38	45	...	60	...	...	...	...	...	...
24 x 12	26	36	43	...	56	72	...	...	...	...	...
24 x 13	...	20	25	30	35	...	...	...	...	...	...
24 x 15	...	35	45	...	60	70	...	...	...	...	...
24 x 36	...	...	77	95	114	150	169	...	...	...	...
30 x 9	37	44	60	...	80	...	...	...	...	...	...
30 x 12	35	42	55	...	76	110	...	...	...	...	...
30 x 13	...	22	30	...	40	...	...	...	...	...	...
30 x 15	...	40	50	...	72	100	...	...	...	...	...
30 x 18	...	...	43	44	53	73	...	...	...	...	...
30 x 20	...	...	55	...	75	95	105	130	...	220	250
30 x 42	...	...	...	125	150	200	225	300	...	...	...
36 x 6	30	50	...	...	...	...	...	...	...	...	...
36 x 8	40	60	80	...	108	...	...	...	...	...	...
36 x 10	47	67	80	...	105	...	...	...	...	...	...
36 x 12	40	55	65	...	91	...	...	...	...	...	...
36 x 14	35	45	55	...	...	...	...	...	...	...	...
36 x 15	40	50	60	...	...	...	...	...	...	...	...
36 x 16	...	65	75	...	95	140	165	...	...	...	...
36 x 18	...	...	65	70	75	...	...	...	...	...	...
36 x 20	...	...	70	...	90	135	160	...	...	...	...
36 x 24	...	50	80	...	125	155	195	...	...	...	...
36 x 25	...	...	...	...	...	200	240	260	...	...	...
36 x 29	...	...	...	...	...	...	...	...	...	275	320
36 x 30	...	...	...	...	...	...	...	150	...	...	...
36 x 42	...	...	120	140	160	200	250	...	...	...	...
36 x 48	...	...	130	150	175	225	275	325	...	...	...
42 x 25	...	...	90	...	150	180	215	250	...	...	...
42 x 27	...	...	...	...	...	170	200	225	...	...	...
42 x 30	...	...	...	...	...	180	215	225	...	300	350
42 x 32	...	...	...	...	...	250	290	330	...	...	...
42 x 36	...	...	...	...	...	120	...	180	...	325	375
42 x 38	...	...	...	...	85	150	...	...	...	...	...
42 x 40	...	...	...	...	...	150	...	200	...	...	...
42 x 48	...	...	...	165	190	250	300	350	...	...	...
48 x 13	85	...	100	...	220	...	...	...	...	...	...
48 x 15	...	...	...	...	120	250	...	...	...	...	...
48 x 36	...	...	...	...	...	150	185	210	...	375	440
48 x 42	...	...	...	...	...	...	...	200	...	375	440
48 x 60	...	...	...	...	220	280	340	400	550	...	...
54 x 84	...	...	...	...	...	...	500	580	820	900	1,000
56 x 72	...	...	...	...	...	315	380	450	640	...	...
60 x 42	...	...	...	...	...	250	...	500	...	...	...
60 x 48	...	...	...	...	...	...	...	500	...	...	...
60 x 84	...	...	...	...	...	...	500	580	820	900	1,000

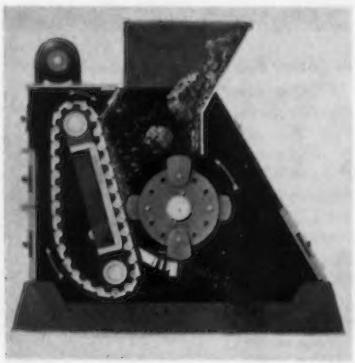
** *See note elsewhere.*



(Courtesy Straub Mfg. Co.)

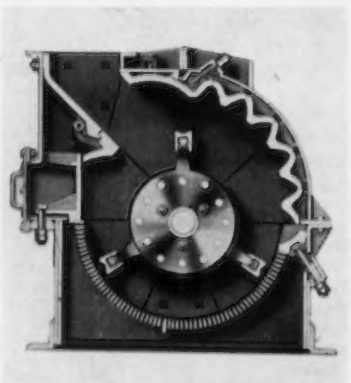
BLAKE type crusher uses double toggle and pitman to move lower end of jaw.

Impact Crushers and



(Courtesy Jeffrey Mfg. Co.)

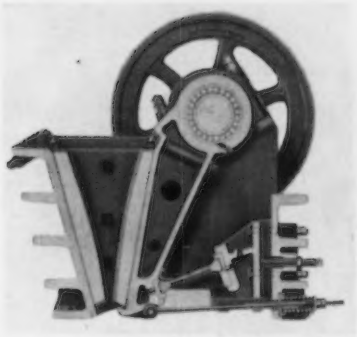
MOVING striking plate on this model prevents wet feed from plugging unit.



(Courtesy Allis-Chalmers Mfg. Co.)

HAMMER MILLS differ from impacters in that hammer mills have screens.

Single Toggle Type and/or Fine Reduction Jaw Crushers**



(Courtesy Smith Engineering Works)

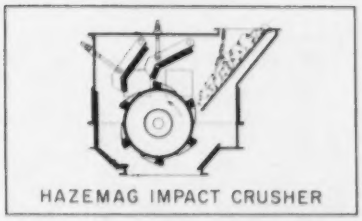
SINGLE TOGGLE crushers move the jaw through eccentric in top bearing.

Approximate crushing capacity in tons per hour of 100 lb per cu ft feed

Size (in.)	Jaw setting (in.) ¼	½	¾	1	1¼	1½	2	2½	3	4	6	8	10
3.75 x 2.25	1.5	3.5	...	...	...	...	...	...	...	...	...	...	...
5 x 6	...	0.7	...	1.5	...	2.5	...	5	...	...	...	...	...
6 x 3	3	7	...	15	...	...	...	...	...	...	...	...	...
6 x 12	...	2.5	3	3.5	4	4.5	5	...	...	...	...	...	...
8 x 10	...	1.3	...	4	...	7	...	10	12	...	...	...	...
8 x 15	...	...	5.5	6.5	7.5	8.5	10	11	...	...	...	...	...
9 x 12	...	1.7	2	5.5	8	11	16	21	27	...	...	...	...
9 x 14	...	2	3	7	9	13	19	24	31	...	...	...	...
9 x 16	...	3	6	8	11	16	21	27	35	...	...	...	...
10 x 4	3	7	...	15	...	...	...	...	...	...	...	...	...
10 x 16	...	3	6	8	...	11	15	23	22	30	...	...	...
10 x 20	...	6	9	13	15	18	28	37	46	...	...	...	...
10 x 24	...	7	10	16	20	23	33	44	54	...	...	...	...
10 x 30	...	8	15	20	28	36	48	64	80	...	...	...	...
10 x 36	...	8	16	22	35	47	57	63	85	...	...	...	...
11 x 30	...	8	...	20	...	36	...	64	80	...	...	...	...
14 x 24	...	...	...	...	...	24	32	40	48	...	...	...	...
15 x 24	...	...	...	...	25	27	37	47	68	90	95	...	...
15 x 36	...	...	...	...	...	42	62	80	100	140	165	...	...
15 x 38	...	...	...	...	...	...	57	71	86	100	...	...	...
18 x 9	4	8	12	16	24	...	...	...	...	...	...	...	...
18 x 24	...	...	...	...	25	33	45	55	80	90	95	...	...
18 x 32	...	...	...	...	...	...	...	60	72	96	120	...	...
18 x 36	...	...	...	...	...	...	68	75	120	150	160	...	...
20 x 4	7	15	...	30	...	...	...	...	...	...	...	...	...
20 x 36	...	...	...	...	...	...	80	90	95	120	190	...	...
21 x 36	...	...	...	...	...	...	75	80	92	128	173	...	...
24 x 10	8	12	18	24	30	36	...	...	...	...	...	...	...
24 x 36	...	...	...	...	...	...	80	100	120	140	180	340	...
25 x 36	...	...	...	...	...	...	...	...	118	135	203	...	...
25 x 40	...	...	...	...	...	...	...	...	150	200	270	375	...
30 x 4	12	25	35	50	...	...	...	...	...	...	...	...	...
30 x 36	...	...	...	...	...	...	...	...	135	180	270	360	450
30 x 42	...	...	...	...	...	...	...	...	...	200	300	400	...
32 x 40	...	...	...	...	...	...	...	...	...	200	350	500	500
40 x 48	...	...	...	...	...	...	...	...	...	300	475	650	750
42 x 48	...	...	...	...	...	...	...	...	...	...	515	685	1,025
44 x 48	...	...	...	...	...	...	...	...	350	425	575	650	950

** See note elsewhere.

Hammer Mills



HAZEMAG IMPACT CRUSHER

(Courtesy Hazemag, mbh)

Typical Approximate Capacity Of Impact Crushers*

Size of feed opening (in.)	Maximum feed size (in.)	Approximate capacity in tons per hour on wet iron ore with single direction type impeller at these sizes in inches. ¾	1½	2
20 x 12	6 x 6 x 4	12	25	25
36 x 24	14 x 16 x 8	87	137	175
42 x 36	16 x 24 x 12	112	187	300
42 x 50	16 x 40 x 12	167	275	350
42 x 70	16 x 60 x 12	230	385	490
54 x 70	24 x 60 x 20	280	470	600

* Courtesy Jeffrey Mfg. Co.

Typical Hammer Mill Capacity

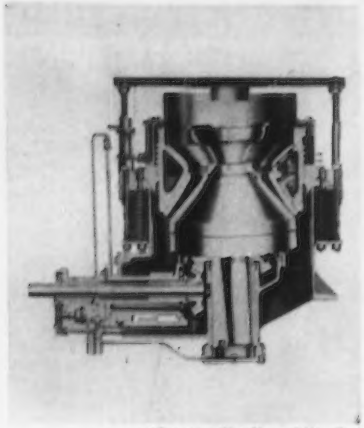
Size of feed opening (in.)	Approximate capacity in tons per hour of 100 lb per cu ft rock with these openings between grate bars (in.) ⅛	¼	½	1	1¼	1½
6¼ x 9	2½	5	10	...	...	...
12 x 15	9	17	29	36	39	...
15 x 25	18	31	47	65	70	...
15 x 49	36	63	95	130	140	...
17½ x 20	5	7	11	17	...	21
23 x 20	8	12	14	22	...	22
25½ x 26¼	...	19	...	35	70	...
28½ x 20	13	18	19	27	...	38
39½ x 20	20	25	28	38	...	52

What to Expect in Your Jaw Crusher Product*

If you aim at this product size	You'll find that the product will have the following approximate per cent passing these square mesh screen sizes, with the crusher set to produce 15% oversize. Screen sizes in inches. ⅛	¼	½	¾	1	1½	2	2½	3	4	5
¼	45	85	...	...	...	...	...	...	...	...	...
½	25	45	85	...	...	...	...	...	...	...	...
1	15	25	45	65	85	...	...	...	...	...	...
1½	12	20	30	45	60	85	...	...	...	...	...
2	10	15	25	35	45	65	85	...	...	...	...
3	...	...	20	25	30	45	60	75	85	...	...
4	...	...	15	20	25	35	45	55	65	85	...
5	...	...	...	15	20	30	40	45	55	65	85

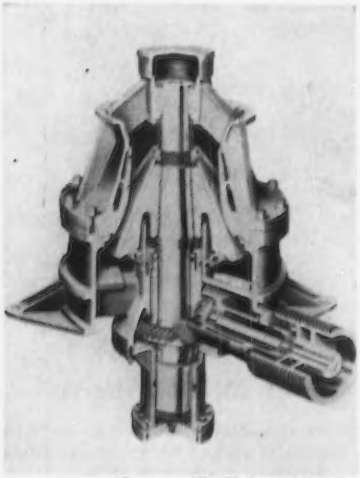
* Courtesy Austin-Western Co.

Gyratory Crushers



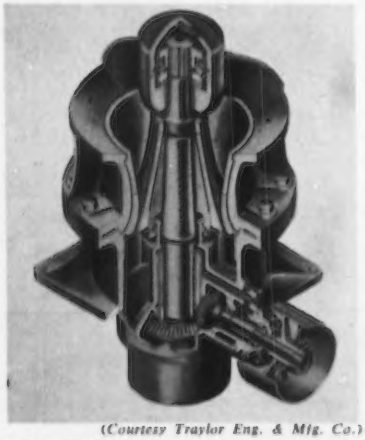
(Courtesy Nordberg Mfg. Co.)

CRUSHER heads come in cone, standard, or short head (above) design.



(Courtesy Allis-Chalmers Mfg. Co.)

DISCHARGE settings are controlled in several ways—hydraulically here.



(Courtesy Traylor Eng. & Mfg. Co.)

NON-CHOKABLE heads and curved concaves permit choke feeding, high capacity.

For Fine Grinding**

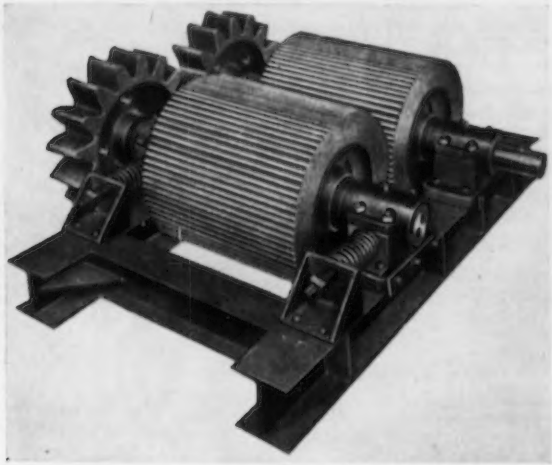
Crusher size (in. dia)	Feed opening (in.)	Approximate capacity in tons per hour of 100 lb per cu ft feed at these discharge settings on the closed side, in inches.							
		⅛	¼	½	¾	1	1¼	1½	2
15	3	...	6	...	...	...	...	...	...
18	1¾	...	10	26	36	...	...	...	...
18	2½	...	...	17	21	24	...	...	...
18	3	...	...	26	36	...	...	...	...
20	3	...	...	20	...	...	...	...	...
20	4½	...	...	20	30	...	...	...	...
22	1	10	13	20	...	...	...	...	...
22	2	...	19	19	...	...	...	...	...
22	3	...	14	36	40	44	...	...	...
24	2½	8	13	...	...	...	...	...	...
28	1¾	...	18	38	53	...	...	...	...
28	3	...	...	38	53	...	...	...	...
28	3¾	...	...	...	53	68	74	...	...
28	4	...	...	...	43	50	...	...	...
28	5	...	...	42	52	...	...	...	...
28	5½	...	...	53	63	...	...	...	...
28	9	...	...	45	68	78	85	91	...
30	1½	14	24	39	...	...	...	...	...
30	3	11	25	...	...	...	...	...	...
30	5	...	20	51	68	72	76	80	...
36	2	20	40	60	...	...	...	...	...
36	3	...	20	50	...	...	...	...	...
36	3¼	...	...	50	60	...	...	...	...
36	4	...	38	79	...	...	...	...	...
36	4½	...	...	50	60	90	110	...	...
36	6	...	...	64	108	128	136	145	162
36	7	...	...	74	87	96	...	...	...
36	7½	...	...	...	...	75	80	95	110
36	12	...	...	57	97	111	123	133	...
48	3	28	68	110	140	...	...	...	...
48	4	...	50	90	...	...	...	...	...
48	5	...	62	128	195	...	...	...	...
48	8	...	...	83	135	192	237	249	275
48	10	...	...	...	140	160	220	...	...
48	16	...	...	...	...	112	148	166	197
51	3½	...	40	125	160	...	...	...	...
51	6	...	70	145	205	235	255	...	...
51	10	...	...	90	160	235	305	330	355
60	4	...	85	160	205	...	...	...	...
60	7	...	...	190	300	320	330	...	...
60	12	...	...	...	200	265	350	460	490
66	5¾	...	95	170	235	...	...	...	...
66	13	...	...	...	...	...	314	358	440
66	22	...	...	...	...	...	...	390	522
80	20	...	...	...	...	...	...	155	203
82	8	...	...	...	...	...	31	35	...
84	5	...	150	350	390	...	...	...	...
84	10	...	...	275	440	655	675	695	...
84	17	...	150	350	390	440	550	690	1,005

** *See note elsewhere.*

For Coarse Reduction**

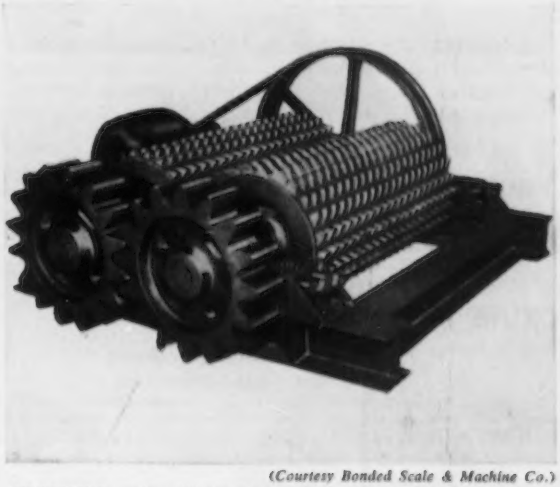
Crusher size (in. dia)	Feed opening (in.)	Approximate capacity in tons per hour of 100 lb per cu ft feed at these discharge settings on the closed side, in inches.						
		1½	2	3	4	6	8	9
104*	30	....	345	495	625	910	....	....
121*	36	....	....	595	750	1,070	....	....
121*	42	....	....	675	860	1,220	1,550	....
151*	48	....	....	....	1,050	1,500	1,910	2,100
151*	54	....	....	....	1,250	1,790	2,250	2,500
168*	60	....	....	....	....	2,500	3,200	3,450

* *Estimated.*
** *See note elsewhere.*



(Courtesy Bonded Scale & Machine Co.)

ROLL CRUSHER capacity is determined by size of finished product and type of roll used—corrugated under one inch.



(Courtesy Bonded Scale & Machine Co.)

TOOTHED rolls will break to ¾-in. on 24-in. dia rolls on 2-in. feed, and to ¾-in. with 72-in. rolls and 5-in. feed.

Recommended Crusher Sizes—Various Shovel Capacities*

Shovel dipper (cu yd)	Jaw crusher size (in.)	Gyratory crusher size (in.)
¾	25 x 36, 30 x 42	16 or 20
1	25 x 36, 30 x 42	16 or 20
1¼	30 x 42, 42 x 48	20 or 25
1½	36 x 42, 42 x 48	20 or 25
2	40 x 48, 42 x 48	30 or 36
2½	48 x 60, 42 x 48	36 or 42
3	48 x 60	42 or 48
3½	48 x 60, 56 x 72	42 or 48
4	56 x 72, 60 x 84	48 or 60
5	60 x 84, 66 x 84	60 or 72

* *Courtesy Smith Engineering Works, from their* Aggregate producers Handbook.

NOTE

The information on the various types of crushers, as presented here, was obtained through questionnaires sent to the manufacturers listed below. *E&MJ* is indebted to those manufacturers who submitted material that went into the jaw crusher and gyratory crushing capacity tables. If you're in the market for a crusher, pick the kind and size you need, then consult the Buyers' Guide section of this guidebook for the manufacturers.

Questionnaires were set to—Allis-Chalmers Mfg. Co., Alloy Steel & Metals Co., Bico, Inc., Austin-Western, Birdsboro Steel Foundry & Machine Co., Denver Fire Clay Co., Denver Equipment Co., Dominion Engineering Co., Ltd., Farrel-Birmingham Co., Inc., American Pulverizer Co., Allen-Sherman-Hoff Co., Braun Corp., Bonded Scale & Machine Co., Bath Iron Works, McNally Pittsburgh Mfg. Co. and McLanahan & Stone Corp.

Also included in this survey were Lippman Engineering Works, Kennedy-Van Saun Mfg. Co., Joy Mfg. Co., Heyl & Patterson, Inc., Holmes & Bros., Inc., Gundlach Crusher & Pulverizer Co., Fahrenwald Machinery Co., Diamond Iron Works, Hazemag, Iowa Mfg. Co., Jeffrey Mfg. Co., Exolon Co. and Link Belt Co.

In addition, the following were questioned—Morse Bros. Machinery Co., Nordberg Mfg. Co., Pettibone Mulliken Corp., Pioneer Engineering Works, Smith Engineering Co., Sturtevant Mill Co., Stroh Process Steel Co., Stephens-Adamson Mfg. Co., Universal Engineering Corp., Wilmot Engineering Co., Rogers Iron Works Co., Straub Mfg. Co., Stearns Roger Mfg. Co., Simplicity Engineering Co., Traylor Engineering & Mfg. Co. and Williams Patent Crusher & Pulverizer Co.

Roll Crushers

Maximum Recommended Feed Sizes*

Shell type	Minimum product (in.)	Maximum feed sizes for each roll size and shell type — Roll diameters (in.)						
		24	30	36	42	48	60	72
Smooth	1/16	3/4	1	1 1/4	1 1/2	1 3/4	2 1/4	2 3/4
Herringbone corrugation	3/8	1 3/8	1 11/16	2	2 5/16	2 5/8	3 1/4	4
Standard corrugation	1 1/8	2	2 3/8	2 3/4	3 1/8	3 1/2	4 1/4	5 1/2
Inverted saw tooth	3/4	2	2 3/8	2 3/4	3 1/8	3 1/2	4 1/4	5 1/2

* *Courtesy Lippman Engineering Works*

Approximate Capacities of Single-Roll Crushers*

Product size (in.)	Capacity in tons per hour of hard bituminous coal, maximum 14-in. size with 66% plus 3-in., at 80 to 90% passing the product size. Roll sizes are dia x face.							
	24 x 24	24 x 30	24 x 36	30 x 24	30 x 30	30 x 36	30 x 42	30 x 54
7/8	10	10	15	25	30	35	45	55
1	15	15	20	30	35	40	50	65
1 1/8	20	25	30	35	40	50	55	75
1 3/8	25	30	40	40	50	60	70	90
2	30	35	45	45	60	70	85	105
2 3/4	35	45	50	55	65	80	95	120
3 1/4	40	50	60	60	70	85	100	130
4	45	55	65	65	75	90	110	140
5 1/4	50	60	70	75	90	110	135	165

* *Link-Belt Co.*

Approximate Capacities of Double Roll Crushers*

Roll size dia x face	Maximum feed (in.)	Roll rpm	Capacity in tons per hour of hard bituminous coal at these square opening screen sizes in inches.					
			1	1 1/4	1 1/2	2	4	6
18 x 15	4 to 8	150	20	25	30	35	60	...
20 x 18	4 to 10	150	30	35	40	50	85	...
24 x 20	6 to 16	130	40	50	55	70	110	160
24 x 30	6 to 16	130	55	70	80	100	130	240
24 x 36	6 to 16	130	65	80	90	115	170	270
30 x 36	8 to 20	115	80	100	115	145	245	350
30 x 48	8 to 20	115	110	130	150	190	330	450

* *Courtesy Jeffrey Mfg. Co.*

Vacuum and Pressure Filters For

THE NUMBER AND VARIETY of filters now available on the market is seemingly endless. On this and the following pages we attempt to illustrate the basic filter types of some of the manufacturers. By no means is this list complete. In addition, a description of the types of filter cloth is included.

Vacuum and Pressure Equipment for Concentrate

DRUM FILTERS

Internal Drum

Manufacturer	Size range dia ft	Cloth area sq ft	Remarks
Dorr-Oliver Inc.	4 to 14	18 to 783	Drum acts as its own filter well. Designed for fast settling solids and those that tend to blind the cloth. Discharge is by blow-back from inside top.

Top Feed Drum

Manufacturer	Size range dia ft	Cloth area sq ft	Remarks
Peterson Filters & Engineering Co.	4 and 6	12 to 200	High frequency vibrator consolidates the cake on the drum, offers excellent dewatering. Feed well is on top of the unit to give 70% effective drying area.
Dorr-Oliver Inc.	6	37 to 94	

Hopper Dewatering Top Feed Drum

Manufacturer	Size range width ft	Cloth area sq ft	Remarks
Denver Equipment Co.	2 to 6	10 to 100	Designed for fast settling and crystalline solids. Can be adapted to dry the cake. Bottom discharge.
Eimco Corp.	1 to 5	9.5 to 94	
Dorr-Oliver Inc.	2 to 6	50 to 150	

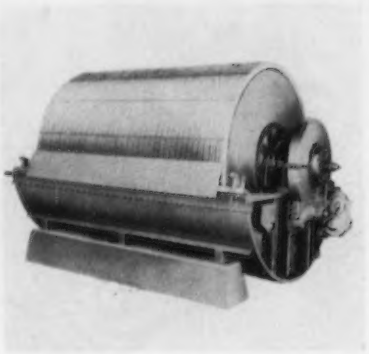
Single and Multiple Compartment Drums

Manufacturer	Size range dia ft	Cloth area sq ft	Remarks
Dorr-Oliver Inc.	3 to 14	18 to 790	Both vacuum and pressure filters are available in either single or multiple compartment design. Single compartment uses scraper discharge. Multiple compartment uses blow-back with or without scraper.
Eimco Corp.	1.5 to 14	4 to 1,056	
Morse Bros. Machinery Co.	3 to 10	9 to 500	
Denver Equipment Co.	4 to 6	19 to 113	
Peterson Filters & Engineering Co.	4 to 6	12 to 188	

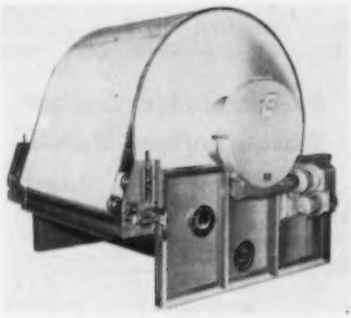
Bird Machine Co. and Komline Sanderson Engineering Co. also make this type.

String Discharge Drum

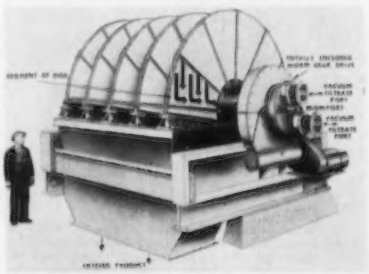
Manufacturer	Size range dia ft	Cloth area sq ft	Remarks
Dorr-Oliver Inc.	3 to 14	18 to 790	Strings pull cake away from drum. No blow-back or scraper required.
Eimco Corp.	1.5 to 14	4 to 1,056	Stainless steel wires replace the normal strings.



(Courtesy Morse Bros. Mach. Co.)
DRUM filters can be single or multiple compartment with or without blowback.



(Courtesy Eimco Corp.)
STRING DISCHARGE drum lifts cake off drum with steel wire or string layer.



(Courtesy Denver Equipment Co.)
DISK filters have great capacity and cloth area for their small floor space.

(Courtesy Bird Machine Co.)
TILTING PAN rotary horizontal filter keeps feed and wash liquors separate.

Concentrate and Process Water

Semi-Continuous Precoat Drum

Manufacturer	Size range dia ft	Cloth area sq ft	Remarks
Dorr-Oliver Inc.	3 to 10	18 to 500	Open-type unit.
	3 to 10	18 to 165	Closed-type unit for use where temperature must be controlled or where gases might escape. Both vacuum and pressure types available.
Eimco Corp.	3 to 8	9 to 600	Open type.
	3 to 8	9 to 200	Closed type. Same data as above. High or low submergence on request.

Magnetic Assisted Drum

An Oliver filter was altered by Loussavaara Kiirunavaara, Malmberget, Sweden, to permit the hanging of magnets inside the drum. Magnets improved the dewatering of magnetite concentrate. Capacity was 12 tons per sq ft cloth area per hour.

DISK FILTERS

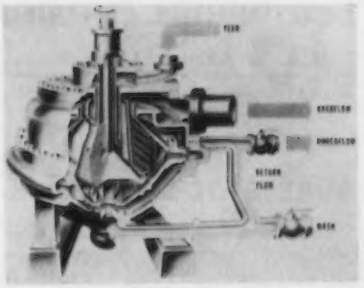
Manufacturer	Size range dia ft	Cloth area sq ft	Number of disks
Eimco Corp.	1½ to 12	3 to 2,800	1 to 14
Denver Equipment Co.	2 to 9	5 to 1,260	1 to 12
Dorr-Oliver Inc.	4 to 12½	22 to 2,400	1 to 12
Morse Bros. Machinery Co.	4 to 8½	22 to 800	1 to 8
Peterson Filters & Engineering Co.	3 to 10½	3 to 2,000	1 to 14

HORIZONTAL FILTERS

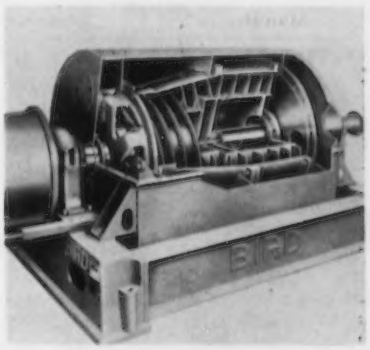
Manufacturer	Size range dia ft	Cloth area sq ft	Remarks
Bird Machine Co.		27 to 516	Continuous tilting-pan type. Many pans.
Eimco Corp.		30 to 600	Continuous tilting-pan type. Many pans.
Dorr-Oliver Inc.	3 to 19	4 to 275	Continuous rotary with scroll screw-type discharge.
Galigher Co.	3, 4 and 5	7, 12 and 19	Batch. Individual pans that tilt to unload.
Denver Equipment Co.	2x2 to 5x5	4 to 25	Batch. Single or double pans.

TRAVELING PAN OR BELT FILTERS

Manufacturer	Sizes available	Cloth area sq ft
Dorr-Oliver Inc.	5	65 to 195

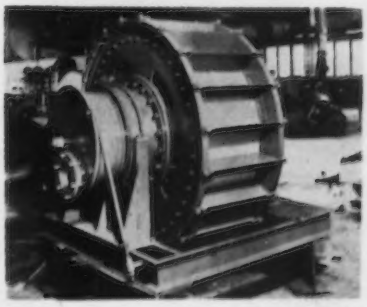


(Courtesy Dorr-Oliver Inc.)
CENTRIFUGALS make clear-cut separations at up to 250 gal per minute.



(Courtesy Bird Machine Co.)
CENTRIFUGALS will give up to 99% recover on feed all minus 150 mesh.

(Courtesy Dorr-Oliver Inc.)
ROTARY HORIZONTAL uses scroll-screw discharge to unload cake.



(Courtesy Eimco Corp.)
TOP FEED HOPPER dewatering filters work best of fast settling solids.

(*Continued on p 98*)

Pressure Equipment for Concentrate

DRUM FILTERS

Drum filters in single, multiple compartment or precoat design can be converted to pressure construction upon demand.

DISK FILTERS

Disk filters can be converted to pressure design upon request.

CONTINUOUS CENTRIFUGALS

Manufacturer	Capacity	Remarks
Bird Machine Co.	up to 60 tph	Bird continuous centrifugal uses plow screw-type conveyor to discharge cake.
Dorr-Oliver Inc.	4 to 6 tph up to 250 gpm	Mercone Screen Centrifuge. Merco Pressure Centrifuge.

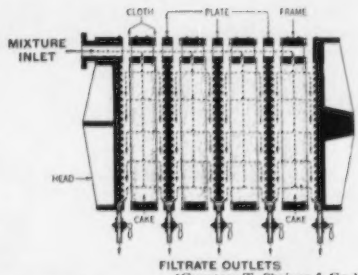
BURT BATCH FILTER

Probably the least known polishing filter, the Burt was designed for gold-cyanide slime dewatering and washing. Sullivan Mining Co. uses it. So does Anaconda Co. in the carbonate leach section at Bluewater. Burt filter is manufactured by Mine & Smelter Supply Co.

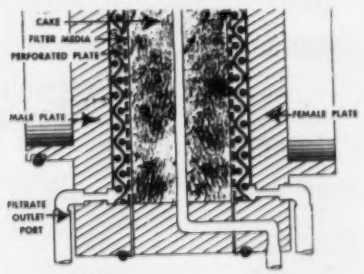
(Courtesy Mine & Smelter Supply Co.)
BURT batch filters are used to treat gold-cyanide slimes and uranium.

FILTER PRESSES

Manufacturer	Trade name	Remarks
T. Shriver & Co.	Shriver Filter Press	Both the flush plate and frame, and the recessed plate types are available. Plates can be supplied in from 7 to 56 in. on a side to permit cloth area from 5 to over 1,000 sq ft.
Dorr-Oliver Inc.	Sweetland Pressure	Cake is dropped after opening the lower compartment, or sluiced out with compartment closed. Sizes range from 10 to 1,044 sq ft cloth area.
Denver Equipment Co.	Denver Filter Press	Number of frames and total cloth area designed to suit your purpose.
Brosites Products Corp.	Brosites Vertical Plate Filter	Available in plate diameters of from 12 to 42 in. with from 4 to 1,000 sq ft cloth area.
Eimco Corp.	Eimco Burwell	Available with from 7 to 30 frames.
Dorr-Oliver Inc.	Kelly Pressure Filter	Horizontal tank with horizontal and vertical leaves. Leaves are pulled from tank to unload. Sizes range from 3 to 1,300 sq ft cloth area.
Bird Machine Co.	Bird Pressure Filter	Working pressures up to 250 psi possible. From 419 to 1,800 sq ft cloth.



(Courtesy T. Shriver & Co.)
PLATE AND FRAME filters are used to polish process liquors of all kinds.

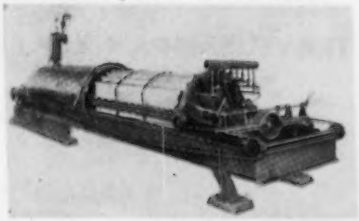


(Courtesy Eimco Corp.)
EIMCO-BURWELL is a series of frames between pairs of filter surfaces.

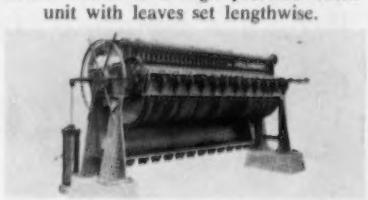
Pressure Filters for Process Water

TANK FILTERS

Manufacturer	Trade name	Remarks
T. Shriver & Co.	Shriver Pressure Filter	Tank with horizontal cloth or filter paper leaves arranged with one to 18 chambers and 1.3 to 23.4 sq ft cloth.
Dorr-Oliver Inc.	Oliver Pressure Filter	Tank with horizontal leaves to give 25 to 100 sq ft cloth area.
Cochrane Corp.	Vertical Pressure Filter	Sand and gravel filter with from 7 to 95 sq ft filter area.
Booth Co.	Booth Pressure Sample Filter	For filtering mill samples. Model has 3-gal capacity.
Denver Equipment Co.	Denver Pressure Laboratory Filter	Available with 28 to 113 sq in. cloth area in four models.
	Denver Counter-Balanced Pressure Filter	One size with 113 sq in. cloth.
United States Filter Co.	Auto-Jet	Available with from 50 to 600 sq ft cloth area. Cake is sluiced off the leaves.



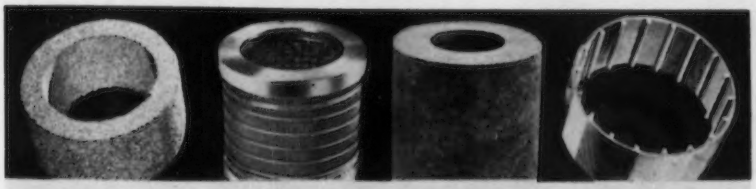
(Courtesy Dorr-Oliver Inc.)
KELLY filter is a high pressure batch unit with leaves set lengthwise.



(Courtesy Dorr-Oliver Inc.)
SWEETLAND pressure filter operates on low pressure, has sight glasses.

SOCK FILTERS

Manufacturer	Trade name	Remarks
Industrial Filter & Pump Mfg. Co.	Hydra-Sock	Tubular filters hung in a tank. Cake is removed by violent blow-back.



(Courtesy R. P. Adams Co., Inc.)
POROUS STONE, screen and wedgewire can be used to filter process water.

POROUS MEDIA FILTERS

Manufacturer	Trade name	Remarks
R. P. Adams Co.	Poro-Stone	Porous stone filter elements hung in a pressurized tank. Can be precoated.
	Poro-Screen	Screen cloth elements hung in a tank. Can be precoated.
	Poro-Edge	Wedge wire screen element that can be precoated.

DRUM AND DISK FILTERS

In many cases where the water contains considerable solids, drum and disk concentrate filters are being used to clean the water.

Facts About Filter Fabric

Cotton has good filtration characteristics, high mechanical strength and low initial cost. It is the standard media on new filters unless otherwise specified on purchase agreement.

Wool is equivalent to cotton and replaces cotton in acid or high temperature situations.

Glass is used in acid and/or high temperature work. It can be used in weak alkali solutions.

Stainless steel is an excellent filter media under certain conditions. It is very good for handling fluorspar.

Dynel is resistant to most acids and bases and to a certain extent to organic acids, bases and salts. Maximum temperature should not be over 200 deg F. It can be sealed in the press frames of plate and frame filters. Dynel has high tensile strength.

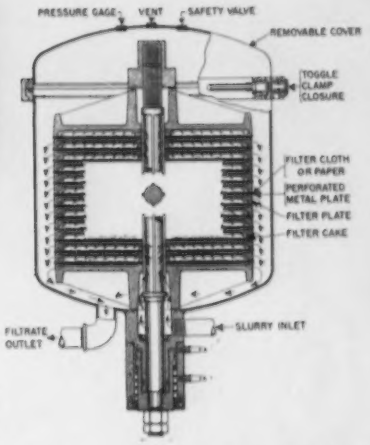
Nylon has high tensile strength and excellent abrasion resistance. It will resist most alkalies and organic acids. Not recommended for strong mineral acids or oxidizing agents. Maximum working temperature should not exceed 300 deg F.

Polyethylene easily resists inorganic acids, alkalies and their salts. At room temperature, it will resist most organic chemicals. Maximum working temperature is about 150 deg F. It has good flexing properties at low temperatures. Its open mesh is suited for coarse crystals, fibrous pulps and free filtering solids.

Orlon has working temperatures up to 300 deg F. It shows excellent resistance to strong mineral acids, and oxidizing agents. It is unharmed by organic solvents, oils and greases. It shows a fair resistance to weak alkalies. Tensile strength and abrasion resistance are good, putting Orlon close to Nylon in ability.

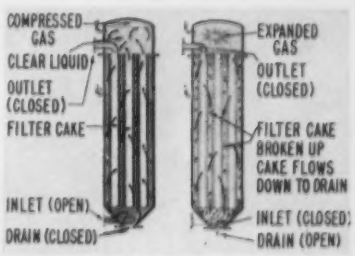
Saran is being used to handle taconite magnetic and flotation concentrate due to its excellent abrasion resistance. It will handle acids and their salts. Do not use Saran in the presence of strong ammonium hydroxide—other bases are okay. It resists organic solvents to some degree. Maximum working temperature is 160 deg F.

Teflon ranks behind Orlon in thermal stability, but shows good chemical resistance and toughness against all solvents and reactive chemicals except fused alkali metals and fluorine gas. It softens at 212 deg F, but can be used at temperatures up to 475 deg F. Under adverse chemical or thermal conditions, Teflon beats all the other synthetics in its abrasion resistance.

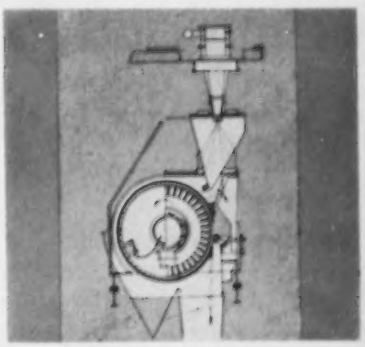


(Courtesy T. Shriver & Co.)
TANK filters are used for process water and chemical filtration work.

(Courtesy Cochrane Corp.)
SAND AND GRAVEL filters use sand, gravel, coal or marble to clean.

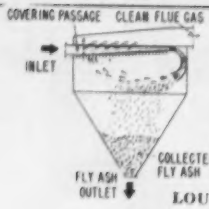
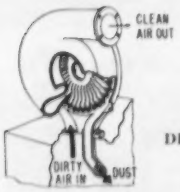
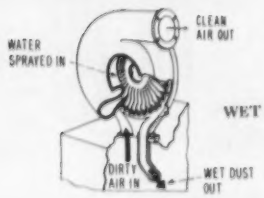
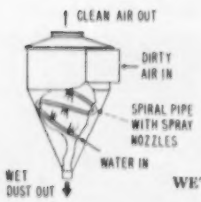
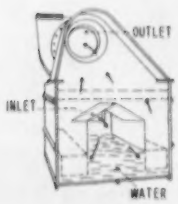


(Courtesy Industrial Filter & Pump Mfg. Co.)
SOCK filters collect sediment from process water in long fabric bags.



(Courtesy Peterson Filter & Eng. Co.)
TOP FEED drum filter is fed from a surge bin set on top of the drum.

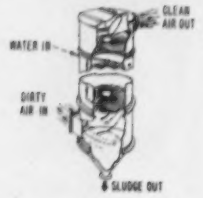
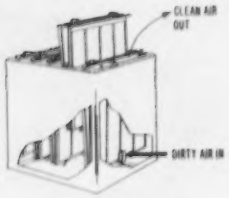
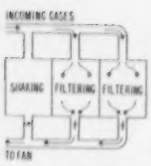
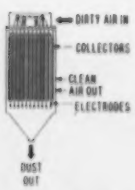
Use This Table to Narrow Down

Collector types	These Dust Characteristics Will Influence Your Choice: Particle size range	Particle size and shape	Dust load	Wettability and disposability	Dust value
 LOUVER	30 micron and up, but coarse sizes will abrade slats	Flaky material sails on through. Sharp particles increase wear	Can handle large surge load, but high load will cause some abrasion and may plug unit	No problem. Dry collecting. Wet or dry disposal	Cannot be used if dust is valuable. Good for fly ash, but not for fume
LOW RESISTANCE CYCLONE	20 micron and up. Works best on plus 200 mesh feed	Flaky material sails on through	Can handle light or heavy load	No problem. Dry collecting. Wet or dry discharge	Used considerably for pneumatic conveying and collecting. No good on fumes
HIGH EFFICIENCY CYCLONE	1 micron and up, but best on plus 10 micron	Sharp particles abrade tube and inlet face	Can handle as little as 3 grains per cu ft or as much as 80. Tends to plug on excessive loading	Dry collecting and discharge through air lock or dust gate	Used to concentrate, size and collect valuable dust. No good on fumes
 DRY DYNAMIC	10 micron and up, but best on plus 200 mesh. Too much coarse will cause fan abrasion	Sharp particles abrade fan	Heavy dust loads increase abrasion rate on fan	No problem. Dry collecting and discharge	Used to concentrate, size and collect. No good on fumes
 WET DYNAMIC	All sizes, but coarse abrades fan	Sharp particles abrade fan	Can handle light or heavy load, but heavy load increases fan abrasion	Dust must be wettable. Wet collecting and discharge	Can be used to collect valuable dust, if discharge can go to process or a thickener
 WET CYCLONE	All sizes	Sharp particles abrade tube and inlet face	Can handle light or heavy load	Dust must be wettable. Wet collecting and discharge	Can be used to collect valuable dust, if discharge can go to process or a thickener
 WET SCRUBBER	All sizes	No problem. Abrasion slight	Can handle heavy load if equipped with sludge ejector that reduces water changing frequency	Must be wettable. Wet collecting and discharge	Can be used to collect valuable dust, if discharge can go to process or a thickener

Your Dust Collector Choice

These Gas Characteristics Influence Your Choice			Check These Design Characteristics		
Temperature deg F	Chemical nature	Pressure and draft losses	Efficiency	Initial cost, maintenance cost and design information	Who makes them
Most designed to work at up to 750. Others designed to withstand 1500	No problem	Low or high pressure. Very little draft loss	Good on fly ash and heavy dust. 99% on plus 100 mesh. 32% of all plus 20 micron	About the lowest cost unit to install and operate. No moving parts. Maintenance cost is about 5% of installed cost per operating year. Small and compact	LR Collector—Buell Eng. Co. Inc. Aerodyne—Research Cottrell Inc. **LOUVER**
Most designed to work at up to 750. Others designed to withstand 1500	No problem	Low or high pressure. Low draft loss—1 to 2 in.	Good on fly ash and heavy dust. 75% of all plus 325 mesh	Low cost unit to install and operate. No moving parts. Maintenance cost is low. Takes up considerable space and is usually placed outdoors	Any and all will build to suit **LOW RESISTANCE CYCLONE**
Most designed to work at up to 750. Others designed to withstand 1500	No problem	Low or high pressure. Some draft losses encountered —3 to 8 in.	Excellent on fly ash and dust in spreader-stroker and pulverized-coal burners. Can hit 99.5% in minus 10 micron range	Cost will run, maybe, $1 per cfm in stainless. No moving parts. Maintenance cost is about 5% of installed cost per year. Singles can be small and compact. Large units in multiple cyclone design are about size of precipitator	AmerClone—American Air Filter Co. Cyclo-trell—Research Cottrell Inc. Multiclone—Western Precipitation Corp. Multiclone—Precipitation Co. of Canada, Ltd. van Tongeren (or Buell)—Buell Eng. Co., Inc. High Efficiency—Fly Ash Arrester Corp. Any and all will build to suit **HIGH EFFICIENCY CYCLONE**
Most designed to work at up to 750. Others designed to withstand 1500	No problem	Fan induces its own draft. No pressure drop	Not good on plus 60 mesh, since heavy particles tend to bounce out	Cost is about same as cyclone above, maybe a little higher. Maintenance cost is about 10% of installed cost per year. Very small and compact	Roto-Clone Type D—American Air Filter Co. Spiral Deduster—Hazemag **DRY DYNAMIC**
Can operate at up to 1500. If corrosive, unit will corrode faster at high temperatures	Good for removing corrosives. Use protective coating over exposed surfaces	Fan induces its own draft. Generally 3- to 6-in. drop	Good on plus 10 micron. 80% on 1- to 10-micron range. Good for taking corrosives from gas stream	Probably twice as expensive as the cyclone. Maintenance cost is about 10 to 15% of installed cost per year. Very small and compact	Roto-Clone Type W—American Al Filter Co. **WET DYNAMIC**
Can operate at up to 1500. If corrosive, unit will corrode faster at high temperatures	Good for removing corrosives. Use protective coating over exposed surfaces	Low pressure unit. Low draft loss—3 to 6 in.	Good on plus 10 micron. 80% on 1- to 10-micron range. Good for taking corrosives from gas stream	Cost about the same as low resistance cyclone. Maintenance cost is about 10 to 15% of installed cost per year. About same size as low resistance cyclone	Any and all will build to suit **WET CYCLONE**
Can operate at up to 1500. If corrosive, unit will corrode faster at high temperatures	Good for removing corrosives. Use protective coating over exposed surfaces	Gas must be pulled through several inches of water. Some draft loss	Good on plus 10 micron. 80% on 1- to 10-micron range. Good for taking corrosives from gas stream	Cost probably in high efficiency cyclone range. Maintenance cost is about 10 to 15% of installed cost per year. About the size of louver	Roto-Clone TypeN—American Air Filter Co. Cycoil Type PO-8—American Air Filter Co. Ventrijet—Pangborn Corp. Hydro-Precipitator—Johnson-March Corp. **WET SCRUBBER**

DUST COLLECTORS

Collector types	These Dust Characteristics Will Influence Your Choice: Particle size range	Particle size and shape	Dust load	Wettability and disposability	Dust value
 SPRAY TOWER	All sizes	No problem	No problem on spray-chamber type, but if of packed tower-type, then high dust load will plug saddle packing	Must be wettable. Wet collecting and discharge	Can be used to collect, if discharge can go to process or a thickener
VENTURI SCRUBBER	All sizes. Excess coarse rapidly abrades mixing chamber	Sharp particles abrade chamber	Heavy dust load increases chamber wear	Must be wettable. Wet collecting and discharge	Can be used to collect, if discharge can go to process or a thickener
 UNIT FILTER	Designed to clean minus 200 mesh dust from process air	No problem	Not designed for heavy loads. Use as ventilation or process air filter	Dry collecting on disposable units. Wet or dry on self-cleaning types	Not designed to collect. Use to clean process or ventilation air only
 FABRIC ARRESTER	Designed for minus 200 mesh, but will collect plus 200	Sharp particles can abrade cloth	Not designed for extremely heavy loads. Use scalping unit ahead	Dry collecting and discharge	Used to collect valuable dust and smelter fume
REVERSE JET ARRESTER	Designed for minus 200 mesh, but will collect plus 200	Sharp particles can abrade cloth	Being used on 50 grain dust loads. May or may not need a scalping unit ahead	Dry collecting and discharge	Used to collect valuable dust and smelter fume
 ELECTROSTATIC PRECIPITATOR	Designed for very fine dust and fume	Sharp particles can abrade electrodes to a minor extent	Works best on light loads. Can be used on heavy load with scalping unit ahead. Usually used when load is below 6 grains per cu ft	Wet or dry collecting and discharge	Used to collect valuable dust and smelter fume

—These Gas Characteristics Influence Your Choice— Temperature deg F	Chemical nature	Pressure and draft losses	Efficiency	—Check These Design Characteristics— Initial cost, maintenance cost and design information	Who makes them
Can operate at up to 1500. If corrosive, unit will corrode faster at high temperatures	Good for removing corrosives. Use protective coating over exposed surfaces	High or low pressure. Slight draft loss—1 to 3 in.	Good on plus 10 micron. 80% in 1- to 10-micron range. Good for taking corrosives from gas stream	Will cost as much as a steel tank with internals, piping and packing (if needed) extra	Ducon Co. **SPRAY TOWER**
Can operate at up to 1500. If corrosive, unit will corrode faster at high temperatures	Good for removing corrosives. Use protective coating over exposed surfaces	Needs high pressure blower. Can have pressure drop as high as 40 in., depending on efficiency required	Good on plus 10 micron. 80% in 1- to 10-micron range. Good for taking corrosives from gas stream	Requires water pump, water supply, and high speed blower. Has high hp demand. Maintenance cost is about 15% of installed cost per year. Small and compact	Joy Mfg. Co. **VENTURI SCRUBBER**
With Orlon or Dacron cloth it can stand up to 275; with wool to 220; with cotton to 180; and with fiberglass to 450-500. If hotter, use spray cooler ahead	Special fabrics in temperature column were developed to withstand most chemicals	Can operate with either positive or negative pressure	Good on plus 10 micron. 80% in 1- to 10-micron range	Too expensive to use as ordinary dust collector. Use on process or ventilation air. Three types available—low velocity, wet or dry; medium velocity, dry; and high velocity, metal cloth or miniature cyclone. Maintenance cost depends on dust load. Small to medium in size	Ultra-Aire—Mine Safety Appliances Co. Unit type—Pangborn Corp. Multi Pack—American Air Filter Co. Airmat—American Air Filter Co. Roll-O-Vent—American Air Filter Co. Impingo Filter—Mechanical Industries, Inc. **UNIT FILTER**
With Orlon or Dacron cloth it can stand up to 275; with wool to 220; with cotton to 180. Fiberglass cannot be used. If hotter, use spray cooler ahead.	Special fabrics in temperature column were developed to withstand most chemicals	Moderate back pressure through bags depending on velocity, dust load, particle size and length of shaking cycle. Pressure drop—2 to 6 in.	Up to 100% on plus 0.1 micron. Good on fume	Cost will vary with specifications. Maintenance cost is low—mostly bag replacement. May require considerable space, but designs are flexible	Pangborn Corp. Dustube—American Wheelabrator Corp. **FABRIC ARRESTER**
With Orlon or Dacron cloth it can stand up to 275; with wool to 220; with cotton to 180. Fiberglass cannot be used. If hotter, use spray cooler ahead	Special fabrics in temperature column were designed to withstand most chemicals	Can operate at up to 5 times more air per sq ft cloth area than shaker. Units that will operate at up to 200 psi available	Up to 100% on plus 0.1 micron. Good on fume	More expensive than shaker-type, up to twice as much in some cases, but generally competitive with shaker. Maintenance cost is low—mostly bag replacement. May require considerable space, but less than shaker-type and designs are flexible	Junkmann—Hazemag Aeroturn—Koppers Co., Inc. Amerjet—American Air Filter Co. **REVERSE JET ARRESTER**
Can operate at up to 1200 with special construction. Standard specification is 750	Corrosive gases, if not dry will attack electrodes. Alloys can be specified to resist attack	Not much pressure drop encountered — under ½-in. Must not condense in dry-type units	Excellent. Designed for very fine fume and dust. Can be designed to suit your requirements	Most expensive collector to install. Needs high-voltage power. Low operating cost. Maintenance cost is about 5% of installed cost per year. Smaller than baghouse, but size depends on efficiency and gas volume	Cottrell—Western Precipitation Corp. Cottrell—Precipitation Co. of Canada Ltd. Electrical Precipitator—Research Cottrell, Inc. Buell SF-Buell Eng. Co., Inc. **ELECTROSTATIC PRECIPITATOR**

E&MJ is indebted to the manufacturers listed above for their technical assistance in preparing this material. Illustrations were furnished as follows—American Air Filter Co. (low resistance cyclone, high efficiency cyclone, wet cyclone, dry dynamic, wet dynamic, wet scrubber and unit filter); Buell Eng. Co. Inc. (louver); Ducon Co. (spray tower); Joy Mfg. Co. (Venturi scrubber); American Wheelabrator Corp. (fabric arrester); Koppers Co., Inc. (reverse jet); and Western Precipitator Corp. (electrostatic precipitator).

SOLVENT EXTRACTION processes begin in laboratory units.

PROCESS equipment is needed to handle 10% solid slurries.

Solvent Extraction—Liquid-Liquid Separation

SOLVENT EXTRACTION, mining and metallurgy's newest processing tool, has been around for a long time. Chemists use it to separate many organic and inorganic solutions in the analytical laboratory.

Solvent extraction is a process whereby an organic reagent is dissolved in kerosene or other mineral spirit to form an extraction solvent that will not mix with water. Each particular solvent is chosen for its affinity for a particular metal or metal group (see list of solvents).

When the solvent comes in contact with an aqueous (usually acidic) solution or dilute pulp (below 10% solids), the solvent extracts those metals for which it has affinity. The solvent is separated from the aqueous solution or pulp by decantation and then the solvent is stripped of its metal content by one of four methods—changing the pH of the solvent, precipitating the metal with reagents, electrolytic precipitation, or distillation of the solvent.

The process is much like countercurrent decantation, except that two liquids are involved, rather than a solid and a liquid. Solids in the aqueous solution can be tolerated at up to 10% pulp density without excessive equipment wear on present-day installations. If equipment can be developed, we may see the day when the ore will be ground, the metal dissolved and separated by the solvent, without an intermediate sand-slime separation.

Solvent extraction is most famous for its application in uranium processing. Two processes have been developed—Dapex and Amex. Dapex process uses phosphoric acid compounds as solvent (see cost table on next page). It has been installed at Kerr McGee, Shiprock, N. M., and at Climax Molybdenum, Grand Junction, Colo. Amex is being piloted by Eldorado Mining & Refining Co. Ltd., Port Radium, N. W. T. This is an amine solvent, rather than a phosphoric type (see cost table on next page).

Also, Vitro Corp. has developed a solvent process which will be installed at Salt Lake City, to replace the current ion-exchange flowsheet.

In addition to its uranium application, solvent extraction can and is being used to recover, refine and purify the following metals: copper, zinc, thorium, vanadium, rare earths, zirconium, hafnium, columbium, tantalum, cobalt, indium and antimony. The table opposite shows those metals and their periodic group partners that can be extracted with suitable solvents.

Advantages are many—low operating cost (see cost data); low capital cost compared to ion-exchange; ideally suited for continuous processing; will work with up to 10% solids in feed solution; produces high purity products; it's easy to control and regulate; and has high through-put potential.

Most serious disadvantage of the process is the fire hazard involved in the use of organic solvents. This can be licked with good common-sense safety practices. In addition, solvent losses through emulsification and entrainment in the solids must be watched carefully. And the process is still in its infancy, calling for considerable laboratory trial and error to determine the best solvent and mineral

Metals and Reagents Used

Uranium
From sulphuric acid solution with dodecyl phosphoric acid
From sulphuric acid with d-2-ethylhexyl phosphoric acid
From sulphuric acid with N-dodecenyltriaklylmethylamine
From nitric acid with dibutyl carbitol
From phosphoric acid with alkyl phosphoric acid (OPPA)

Thorium
From sulphuric acid with di-(tridecyl P) amine

Vanadium
From sulphuric acid with amines

Tantalum
From hydrochloric acid with di-isopropyl ketone

Antimony
From oxalic acid with ethyl acetate

Indium
From hydrochloric acid with di-ethyl ether

Cobalt
From hydrochloric acid with capryl alcohol

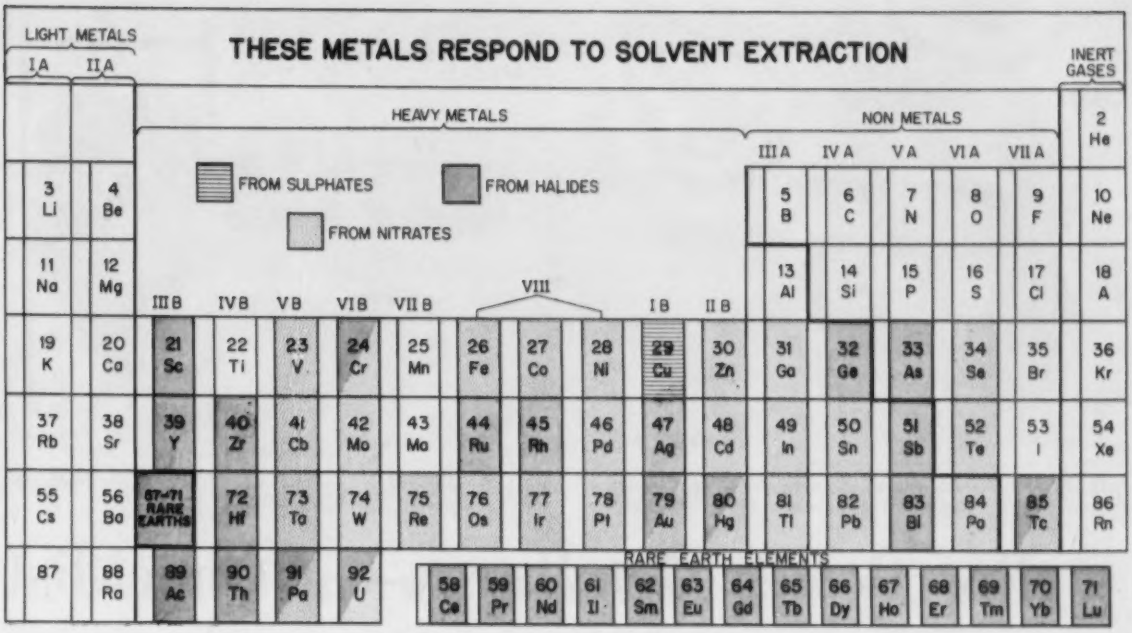


Table redrawn from *Lange's Handbook of Chemistry*, and based on literature available and J. M. Fletcher's "Purification by Solvent Extraction," *IMM*, 1956.

spirit combination, the best operating pH, the stripping agent and method, and the most suitable equipment for continuous solvent extraction.

For both amine and phosphate-type reagents, a little alcohol of the long-chain variety, will assist the extraction. Kerosene is the most common diluent, but mineral spirits (the fraction above kerosene and below gasoline) should be as good, if not better.

Hydrogen ion concentration (pH) affects extraction in that decreasing pH decreases degree of extraction.

Stripping agents may be nitric acid, hydrochloric acid, sulphuric acid, and their salts.

Tables above show some of the reagents that have been used for solvent extraction research. The list is by no means complete. Reagents must show a definite affinity for a particular metal or metal group. It must not be miscible with water. It must be cheap (under $2 a lb). It must be a poor emulsifier to cut down losses through emulsification and entrainment.

Construction cost data. According to F. J. Valle-Riestra (see R. S. Olson and M. F. McCarty, "Solvent Extraction Application in Metallurgical Industry"), a solvent extraction plant with 54 gpm pregnant solution feed rate would cost as follows:

Extract plant	$210,000
Stripping plant	$114,000
Precipitating plant	$176,000

This plant would have a four-stage mixer settler extraction and a four-stage stripping set-up and would require four operators per shift.

These Organic Solvents Can Be Used

1-(3-ethylpentyl)-4-ethyloctylamine
Trialkylmethylamine
N-dodecenyltri-alkylmethylamine
2-(1-isobutyl-3,5-dimethylhexyl) amine
Tridecyl P (mixture of many 13-carbon alkyls)
Heptadecyl amine
Ethylene diamine
Pyridine
Dimethyl ethanolamine
Methyl isobutyl ketazine
Iso-octyl amine
Dodecenyl amine
Di (2-ethylhexyl) phosphoric acid
Dodecyl phosphoric acid
Thenoyltrifluoroacetone
Capryl alcohol
Amyl alcohol
Diethyl ether
Di-isopropyl ether
Dibutyl carbitol
Ethyl acetate
Amyl acetate
Phosphate esters (tributyl phosphate)
Methyl isopropyl ketone
Isobutyl ketone
Hexanone
Di-isopropyl ketone
8-Hydroxyquinoline
Dibutyl phosphoric acid
Armeen 2-12

Estimating Reagent Cost to Recover Uranium*

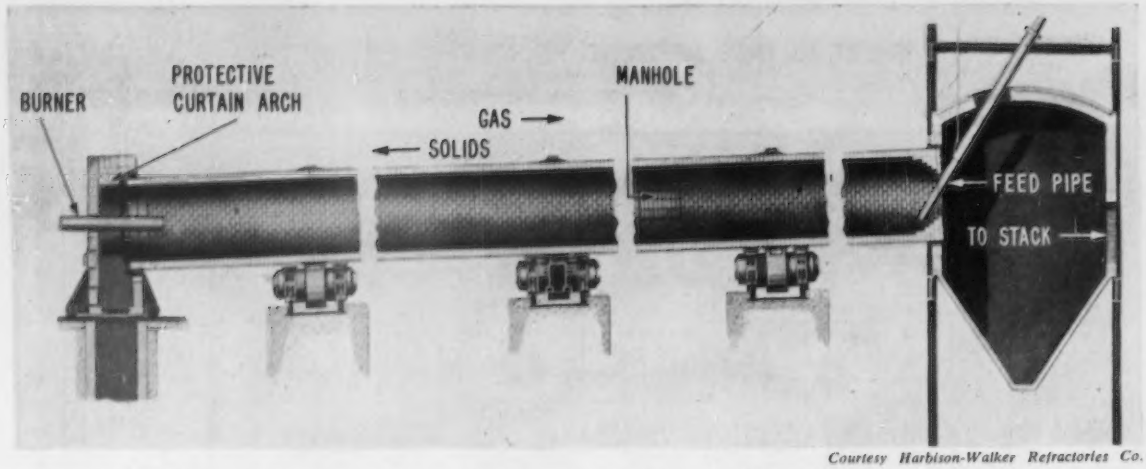
Amex Process, using 0.1 M solution of secondary or tertiary amine diluted with a solution of 95% kerosene and 5% tridecyl alcohol—

Reagent	Use and consumption per lb U_3O_8	Cost in cents per lb of U_3O_8
NaCl	Stripping at 1 M concentration; 2.3 to 3.2 lb at 0.8c per lb	1.8 to 2.6
H_2SO_4	Stripping; 0.2 to 0.3 lb at 1.5c per lb	0.3 to 0.5
NH_3	Recovering U_3O_8 from strip at pH 7; 0.25 to 0.3 lb at 5.8c per lb	1.5 to 1.8
Amine	Loss in process; 0.03 lb at $1 per lb	0.8 to 2.9
Amine, kerosene and tridecyl alcohol	Loss in process; 0.05 gal at 44 to 52c per gal, kerosene costs 14c per lb and alcohol costs 25c per lb	2.2 to 2.6
		Total 6.6 to 10.4

Dapex Process, using 0.1 M solution of di-2-ethylhexyl phosphoric acid diluted with a solution of 97% kerosene and 3% tributyl phosphate—

Na_2CO_3	Stripping; 2 lb at 2.3c per lb	4.6
H_2SO_4	Precipitation; 1.3 lb at 1.5c per lb	2.0
NH_3	Precipitation; 0.25 lb at 5.8c per lb	1.5
Di-2ethylhexyl phosphoric acid	Loss in process; 0.01 lb at $1 per lb	1.0
Tributyl phosphate	Loss in process; 0.022 lb at 60c per lb	1.3
Solvent, kerosene and tributyl	Loss in process; 0.05 gal at 56c per gal	2.8
		Total 13.2

*From "Some New Solvent Extraction Processes For Use in the Hydrometallurgical Treatment of Uranium, Thorium and Vanadium Ores", by K. B. Brown, D. J. Crouse and C. F. Coleman, AIME, New Orleans, 1957.



Courtesy Harbison-Walker Refractories Co.

ROTARY KILNS are one of the most widely used pieces of equipment in pyrometallurgy. Biggest use is for drying but they are also employed for thermal decomposition, chemical conversion, sintering and sublimation.

For Better Metallurgy—A Checklist

Solids-Gas Contacting Operations

This is the Operation	Here's What It Involves
Solid Composition Is Changed	
1. Drying	Removal of unbound liquid, generally water from solids, and the removal of vapors from gas streams by adsorption on solids.
2. Thermal Decomposition of Solids (Calcining fits here)	Often referred to as "calcining." This includes the expulsion of chemically combined water, volatile carbonaceous matter, and the gaseous products of decomposition of compounds such as metal carbonates, nitrates, sulphates, etc.
3. Chemical Conversion of Solids (Roasting comes under this)	Commonly referred to as "roasting." This includes: the removal of impurities by volatilization; the formation of chlorides, fluorides, bromides or iodides, sulphates, etc.: reduction of certain metallic oxides; conversion of non-magnetic compounds into magnetic materials; and alteration of physical properties of materials.
4. Sintering	Agglomeration of a finely divided solid material into a porous cellular cake.
5. Smelting	Charge consists of solids with product in liquid state.
6. Sublimation	Phenomena involving the conversion of solids to gas or gas to solid without presence of liquid.
Solid Composition Remains Unchanged	
1. Heterogeneous Catalysis	Interaction between gases of decomposition of vapor in presence of a solid catalyst.
2. Heat Transfer	Operations where chemical reactions or other phenomena are completely secondary to the transfer of heat, utilizing heat capacity of solids and/or gases.
3. Adsorption	Association between gases and solid surfaces may be either of a physical or chemical nature or both.
4. Chemical Regeneration of Solids	Alternate formation and decomposition of a chemical compound to achieve a desired separation. Heterogeneous Catalysis and Adsorption may be considered special cases of this since some sort of intermediate compound is often formed.

NO METALLURGIST can afford to be without an intimate working knowledge of solids-gas contacting operations; and management men should have at least a nodding acquaintance with solids-gas contacting involving as it does some of the key processes of extractive metallurgy.

Solids-gas contacting for our purposes is essentially the bringing of solid materials (ores, concentrates, chemicals) into contact with gas (air, chlorine, oxygen, etc.), long enough and under proper conditions to accomplish any of the purposes listed in the first column of the table at left.

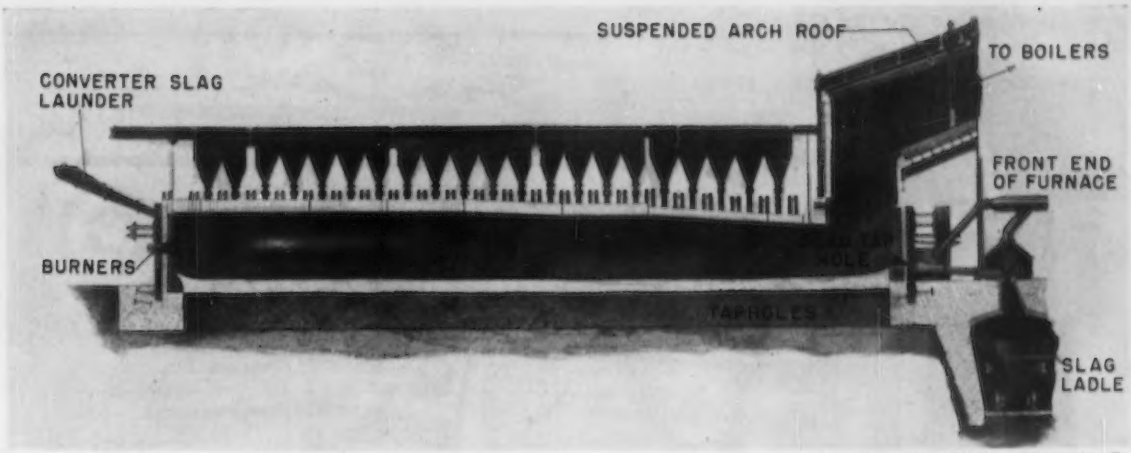
Here is a quick rundown for the operating metallurgist and his management, on the methods and types of equipment available for solids-gas contacting operations. Perhaps in this check of the advantages, limitations and potentialities of these important metallurgical tools, you'll find some new approaches to old problems.

Continuous Process Equipment

Rotary kilns. Rotary kilns or furnaces are among the most important types of process furnaces used in industry. The feed requires little or no size preparation and generally includes a broad range of particle sizes from dust up to large lumps.

Rotary equipment may be grouped into three main categories: roasters or kilns, coolers and dryers.

There are three main zones in a rotary kiln: (1) a drying zone, where moisture is driven off; (2) a heating zone which comprises most of the kiln length; and (3) the heating or burning zone where the charge is de-



Courtesy Harbison-Walker Refractories Co.

SMELTERS like this reverberatory furnace may have all phases of matter, solid, liquid and gas, present during operations but the basic problem is essentially one of solids-gas contacting. The reverberatory is primarily a melting furnace.

# of Solids-Gas Contacting Equipment

composed, oxidized, reduced, etc. Some kilns also contain a recuperator section.

Uses of rotary kilns include calcining of cement, lime, bauxite, magnesite, dolomite, gypsum, clay, vermiculite and innumerable others. They are also used for roasting and chloridizing operations in the processing of gold, silver, titanium and potassium salts. Other uses include volatilizing of mercury and zinc and the sintering of iron ore and phosphate rock.

Rotary dryers are similar to kilns but generally much smaller. Since dryers involve much lower temperatures, no refractory lining is necessary. As a rule both dryers and rotary coolers are set at greater slopes and rotate faster than kilns. Dryers and coolers are generally equipped with ledges or flights on the interior walls, designed to pick up material and spill it through the flow of gas. Dryer applications include the processing of clay, various salts, dolomite, limestone, ilmenite, gypsum, ammonium sulphate, manganese and phosphates.

To accomplish the drying or chemical reaction, hot gases flow either concurrent with or countercurrent to the flow of solids. Although counterflow provides more efficient heat transfer, concurrent flow allows the drying of heat-sensitive materials at higher temperatures.

Rotary equipment is normally used for relatively free-flowing granular materials. Pastes and sludges are handled by special means.

The outstanding advantage of rotary equipment is its adaptability to handle a large variety of mineral, chemical and ceramic products, good

What Equipment, Methods Can Be Used For Solids-Gas Contacting?

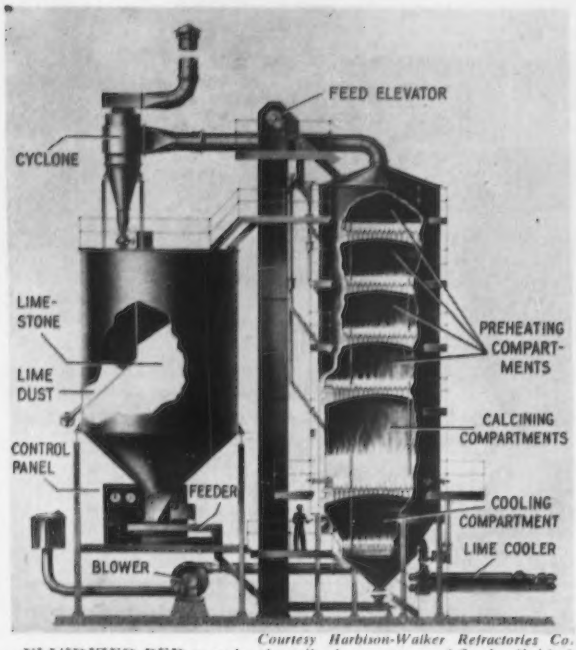
EQUIPMENT, METHODS → / OPERATION	Continuous[1]								Batch[2]		
	Rotary kiln	Mechanical conveyors	Moving bed	Fluidized bed	Spray	Smelters	Multiple hearth furnaces	Fixed bed	Trays and compartments	Pot or autoclave	Special designs
Solids Composition Changed											
Drying	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Thermal decomposition	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Chemical conversion	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sintering	✓	✓	✓	✓					✓		✓
Smelting[3]						✓					✓
Sublimation	✓	✓	✓	✓				✓	✓	✓	✓
Solids Composition Unchanged											
Heterogeneous catalysis		✓	✓	✓				✓			
Heat transfer[4]		✓	✓	✓	✓			✓			
Regeneration of solids			✓	✓				✓			
Adsorption			✓	✓				✓			

[1] Continuous units are those having a steady state flow of gas and/or solids.

[2] Batch units have no flow of gas or solids during operation and composition of both phases is constantly changing.

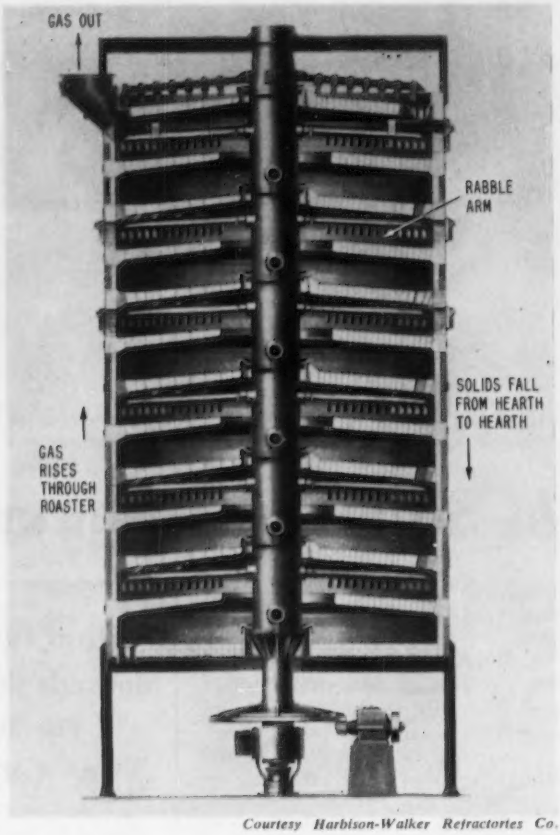
[3] Smelting is regarded as a special case in which products are removed as liquids. Obviously both thermal decomposition and chemical conversion may be taking place during a smelting operation. See text.

[4] Heat transfer referred to here is the basic purpose of the solids-gas contacting operation. Naturally, heat transfer is involved in all solids-gas contacting operations.



Courtesy Harbison-Walker Refractories Co.

FLUIDIZED BED may be described as a mass of finely divided solids maintained in a turbulent, dense state by being dispersed in the upward-moving gas stream.



Courtesy Harbison-Walker Refractories Co.

MULTIPLE HEARTH FURNACE offers wide range of capacities, better temperature control and flexibility than kilns. Main uses are drying and calcining. ➔

quality and uniformity of product, flexibility of throughput and operating conditions.

Fine dusty materials usually cannot be handled in rotary equipment, nor can solids which must meet demanding specifications of size and shape.

Rotary units are particularly well adapted for continuous operations. Furthermore, any given size unit can be made flexible for a wide range of varying capacity, temperature and retention time.

Disadvantages include the relatively inefficient contacting of solids and gases, low heat transfer coefficients when heat is transmitted through the walls of the rotary equipment, and the relatively large size of the equipment per unit of capacity.

Mechanical conveyors. Conveying equipment is characterized by the fact that the solid material is agitated or moved while being contacted with a gas. It includes: screw and vibratory conveyors, contacting towers, gas lifts and belts, moving trays and screens, drums, etc. The conveying operation is, of course, incidental to the solids-gas contacting.

In the screw conveyor a solid is conveyed as it contacts gas flowing in the same or opposite direction. Totally enclosed vibrating conveyors are used with screens or solid decks over which the solid moves, with the gas flowing through or across the solids in a continuous operation.

In the tower contactor the solid cascades down a baffled tower against a rising gas stream. The solid material is simultaneously contacted and conveyed by means of a gas stream in the gas lift.

Most conveyors are characterized by flexibility of operation and low space requirements. The screw conveyor should not be used where product degradation must be avoided, nor the vibratory equipment for materials having long contact times. Due to the short contact time—which may not be advantageous under certain circumstances—temperature-sensitive materials may be contacted in the gas lift. Very abrasive, brittle or sticky substances cannot be handled in a gas lift for obvious reasons.

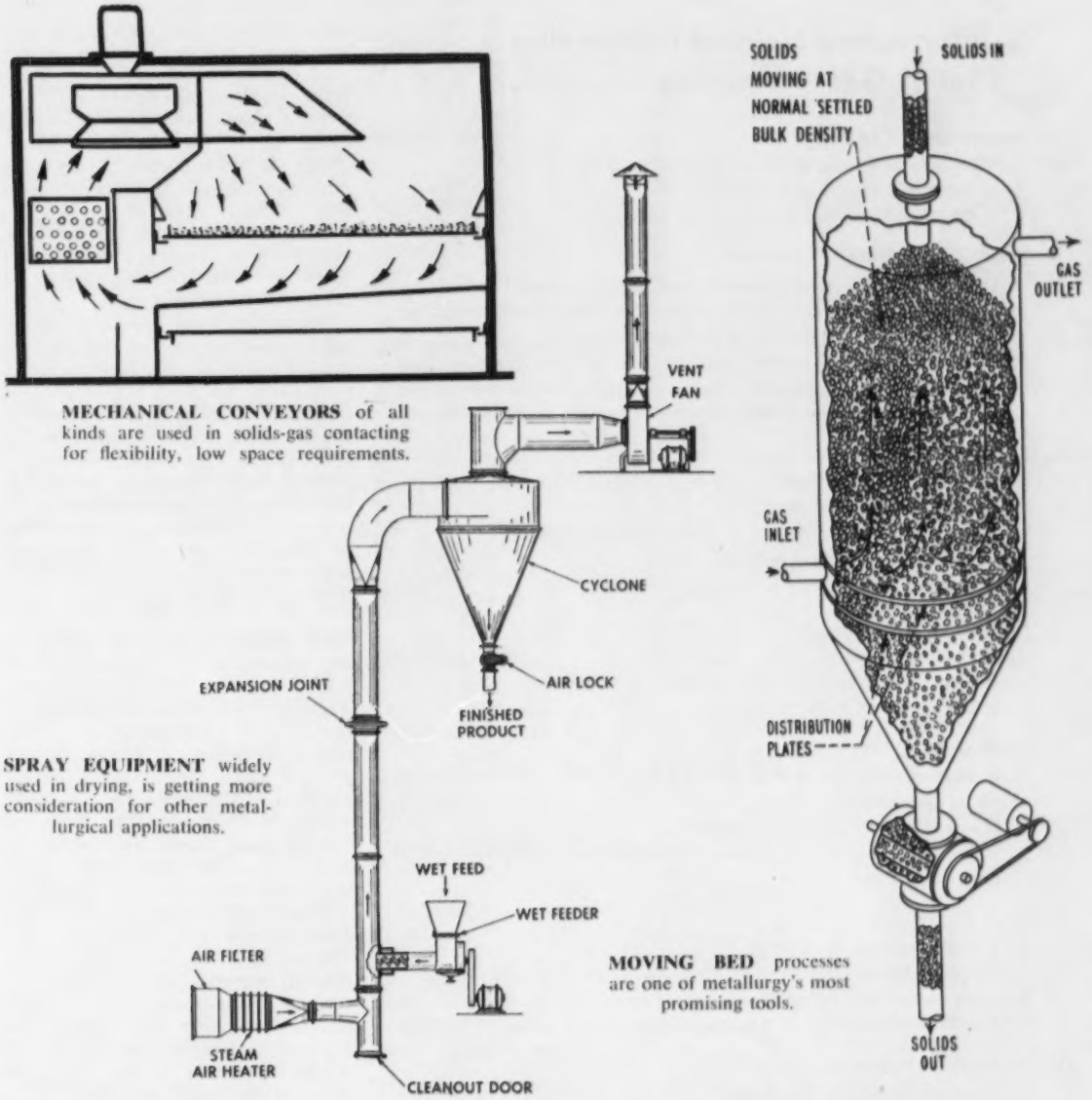
All classes of conveying equipment mentioned require a relatively free-flowing granular feed. An exception is the screw conveyor. It may handle some pastes and sludges.

Tunnel equipment may be considered a variation of mechanical conveyors. Material to be treated in tunnel equipment is placed on trucks which are moved semi-continuously through an enclosed tunnel in contact with hot gases. Gas flow may be parallel or countercurrent to the material flow for efficient operation.

Tunnel dryers are particularly suited to drying materials that tend to warp and check. They are also used for drying large solids and special shapes of all kinds.

Sintering equipment can be considered a special case of mechanical conveying solids-gas contactors where moving trays, belts or screens are utilized.

Moving-bed equipment. The moving-bed principle is widely employed in industry, as indicated by its use in blast furnaces, shaft kilns and petroleum processing. A moving bed can be defined as a body of solids in which the particles—consisting of pellets, beads or briquettes—flow downward by gravity at substantially their normal, settled, bulk density through a vessel in contact with gases. Gas flow may be parallel or countercurrent to



MECHANICAL CONVEYORS of all kinds are used in solids-gas contacting for flexibility, low space requirements.

SPRAY EQUIPMENT widely used in drying, is getting more consideration for other metallurgical applications.

MOVING BED processes are one of metallurgy's most promising tools.

the solids, providing the rate of gas flow upward is not high enough to cause the bed to boil as in fluidization.

The oldest and probably the most important use of a moving-bed or shaft furnace is the blast furnace used for the production of pig iron.

Main limitation of blast furnaces has been in the handling of finely divided material for which reverberatory furnaces are superior. However, the blast furnace has a much higher thermal efficiency.

One of the major advantages of the moving-bed technique is that it lends itself well to the true intimate countercurrent contacting of solids and gases. This provides more efficient heat transfer and a more uniform drying force in the case of mass transfer. The moving-bed contacting method also permits the use of the solid as a heat transfer medium.

The efficiency of solids-gas contacting is high due to uniform distribution of the gas throughout the bed of solids. Feed preparation is an important problem and is largely determined by the physical requirements of the solids. Dust recovery is minimized in this type of unit since a packed bed actually functions as a fairly efficient dust-recovery medium.

The moving-bed technique appears to have a real potential for a wide variety of operations. The operations which have been suggested, studied or applied include drying, reduction, calcination, oxidation, halogenation, sulphatization, volatilization, heat transfer, catalysis.

Potential advantages include flexibility of solid and gas flow rates and capacities, variable retention times, ease of start-up and shut-down, simple provision for concurrent or countercurrent flow permitting large numbers of stages, minimized problems of dust entrainment, suitable temperature control, etc.

Fluidized-bed equipment. A fluidized-bed can be defined as one in which a mass of finely divided solids, ranging from 10 to 400 mesh, is maintained in a turbulent dense state by being dispersed in an upward-moving

Information Needed in Planning a Solids-Gas Contacting Operation

I. Temperature Control.
1. What are the heat quantities involved?
2. Is the solid temperature sensitive?
3. Is the degree of temperature control critical?

II. Solid Composition is Changed.
1. Does the problem simply involve removal of unbound water?
2. Is it necessary to thermally decompose the material with evolution of water and other products of decomposition?
3. Is it desired to chemically react the solids with gases such as oxygen, chlorine, sulphurdioxide, hydrogen, etc? Is the process one of sintering with these products removed as an agglomerate?

III. Solid Composition Remains Unchanged.
1. Does the operation involve physical or chemical adsorption?
2. Is sublimation involved?
3. Does the solid serve merely as a heat transfer medium?
4. Does the solid function only as a filter?
5. Is the solid present only to catalyze the gas reaction?

IV. Product Properties.
1. Cost of product?
2. Product specifications and purities?
3. Is uniformity of product important?

V. Product Recovery.
1. Is dusting from the unit a problem because of health, safety or radiation hazards?
2. How easily may dust be recovered?
3. Is the gaseous effluent processed for recovery of products or better heat utilization?

VI. Feed Properties.
1. Is feed preparation necessary?
2. What are the surface area requirements of reacting solids?
3. Is there a tendency towards agglomeration?
4. Are the feed materials of a corrosive nature?

VII. General Considerations.
1. What capacities are involved?
2. Are countercurrent flow and uniform driving force important?
3. Are the operations flexible enough?
4. What is the total pressure required and what are the pressure drops involved?
5. Is there a need for sweep gases?
6. Is this a steady-state or batch operation?
7. Is the retention time important?

gas stream. The top of the dense phase bed has a well defined level, resembling a boiling liquid. If the gas velocity is further increased, entrainment increases to a point where the bed level disappears and a single dilute phase suspension is present through the entire vessel, as in pneumatic conveying.

The technique appears to have special application for many solids-gas contacting processes, particularly those requiring good control of temperature.

Among the applications that have been studied extensively are: calcination of limestone, dolomite, metal hydrates, magnesite, etc.; drying operations; adsorption; chlorination, including volatilization of metallic chlorides; sulphatization, such as the conversion of copper oxide to copper sulphate; various decomposition reactions; oxidation and reduction.

In a single boiling-bed operation there will be particles which short-circuit the bed and leave rapidly while other particles will undergo extremely long residence times in the bed. To counteract this problem, attempts have been made to design a countercurrent series of beds. The preparation of solid feed is also important.

There are some important advantages: good degree of temperature control and uniformity of temperature throughout the fluid bed, high heat transfer and reaction rates, relatively simple solids removal and makeup, and uniform solid phase composition.

Inherent disadvantages: not adaptable to countercurrent operation; entrainment of solids in gas stream may be prohibitive; the extent of secondary reactions is increased by longitudinal mixing in the bed.

Spray equipment. In spray equipment, the material to be contacted is fed into a hot gas stream as a highly dispersed liquid slurry or solution. A typical spray unit consists of: a contacting chamber, a source of hot gases, a means for atomizing the liquid feed and a means for separating the finely divided product from the exhaust gases. Flash units operate on similar principle with solids rather than liquid dispersed in the gas stream.

Spray equipment may operate with countercurrent or parallel gas flow. The hot gases may be used in a once-through operation, or recirculated.

Spray drying is one of the few commercial-scale operations suitable for the drying of liquids and slurries. It is also applicable to the drying of many heat-sensitive materials.

Among the inherent disadvantages are the relatively low product bulk densities. The equipment, particularly the atomizers, is relatively inflexible and larger evaporative loads are required of spray dryers for a given throughput because of dilution effect.

Principle advantages of spray drying include: Desired product properties and quality values may be efficiently controlled and varied; choice of construction material is often simplified because the material does not contact solid surfaces until it has become dry; due to short contact times it is particularly applicable to the drying of heat-sensitive materials. The use of the spray technique often simplifies other operations such as filtration of the feed or pre-forming of

the solid feed as well as sometimes eliminating the need for size reduction of the dried product.

Flash drying involves the instantaneous removal of moisture from materials by the application of heat in a turbulent stream of hot air.

Flash roasting involves the exposure of a very large surface area of solids to the action of roasting gases, by injecting a stream of finely divided solids directly into the combustion zone. This permits rapid and efficient removal of the gaseous products and increases the speed of reaction to such an extent that the time of roasting may be of the order of seconds.

Flash roasters are particularly well suited for very fine particles such as the sulphides of iron, zinc, copper and nickel which react with oxygen in the air with the generation of heat. Sulphur dioxide and metal oxide are formed.

Smelters. Smelting actions in reverberatory matting furnaces are essentially simple melting operations with solids-gas contacting being instrumental in the heat transfer.

Multiple-hearth furnaces. This type of roaster is in the shape of a vertical cylinder containing a number of superimposed horizontal hearths. Gas enters from the bottom and contacts ore or concentrate which is fed at the top and drops from hearth to hearth in succession until discharged at the bottom.

Multiple hearth furnaces are available in a wide range of capacities and provide better temperature control and operating flexibility than do rotary kilns.

Solids are moved across each hearth and into drop-holes by rabble arms attached to a central rotating shaft.

Retention time of a particle of ore per hearth is controlled by a number of rabbles, angularity of the adjustable rabble teeth and the shaft speed.

Many modifications and variations of the multiple-hearth furnaces are available commercially.

Fixed-bed equipment. The use of equipment containing a fixed bed of solids for contacting operations is very common. The solids range in size from ⅛ in. to 3 in. and may be catalytic—as in the Houdriformer—or noncatalytic. Gas flow through the bed may be upward or downward.

Fixed-bed processes have certain advantages: There is no appreciable solids loss due to abrasion, and equipment is not required to circulate solids or to separate solids to recover them from gas streams. Fixed-bed units possess considerable flexibility.

Among the inherent disadvantages of fixed-bed methods is the difficulty of adding or removing solids during operation. Cyclic operations introduce valving and purging problems that are complicated by very high temperatures and large gas volumes. Due to relatively poor heat transfer characteristics, excessive temperature gradients often exist within the bed.

Batch Equipment

Trays and compartments. Tray and compartment furnaces or dryers are generally restricted to the removal of unbound moisture or other solvent from a solid. Heated gas, generally air, circulates over the material until the solid reaches the required final moisture or solvent content. Such batch units are occasionally used for decomposition reactions.

The use of tray and compartment dryers is usually limited to small batches of materials.

Pot or autoclave. In general, batch furnaces and dryers may be of conventional or special design. Small batches of metals are conveniently melted in pot or crucible furnaces. For non-ferrous metals melting below 1,200 deg F, iron or steel pots are usually satisfactory. Higher melting metals require the use of refractory crucibles.

Autoclaves or "bombs" such as those used for the batch reduction of titanium tetrachloride, zirconium tetrachloride, thorium tetrafluoride and uranium tetrafluoride to metal, using reductant such as calcium, magnesium and sodium, are, in effect, batch solids-gas contacting units.

Retorts. This category might well be incorporated in the tray and compartment group. Vertical retorts are used for close temperature control and semi-continuous operation. Stock is fed at the top at intervals and product is withdrawn from the bottom in small batches, and occasionally from the side. Vertical retorts are used for the production and revivification of bone char, for the reduction of zinc ore and for the production of carbon dioxide gas by burning limestone.

Special designs. The so-called Mannheim furnaces involve special designs of circular muffle furnaces where sulphuric acid is reacted with sodium chloride to produce sodium sulphate and hydrochloric acid. It consists of a refractory hearth with a diameter up to 18 ft and a silicon carbide arch. Hot flue gases are circulated about this muffle, with the major portion of heat transmitted through the arch and radiated on the charge. The charge is worked towards the periphery as the reaction proceeds with the generation of hydrogen chloride gas. The gas is withdrawn to an adsorption system and salt cake is discharged at the periphery.

Batch indirect dryers are usually well suited for operation under vacuum and well suited for handling small production of practically any form of wet solids: liquids, slurries, pastes and granular materials.

Vacuum rotary dryers have found some use as batch units, with the material agitated in horizontal, stationary shelves. Vacuum tray dryers are widely used, particularly in laboratory and pilot plant studies, with heating carried out by contact with steam heated or hot water heated shelves on which the solid is placed. No agitation is involved.

Infra-red dryers operate on principle of transfer of radiant heat, with the heat generated electrically by means of incandescent lamps or by gas-heated incandescent refractories. The use of infra-red radiation for removing water from solids is limited to the drying of thin film or sheet material. It is not generally applicable to handling large massive objects or materials where internal moisture flow is the controlling factor.

In dielectric drying, the material to be dried is heated by placing in a strong electrostatic field produced by high-frequency voltage. While few industrial applications of this type of drying have been reported, many experimental studies have been made.

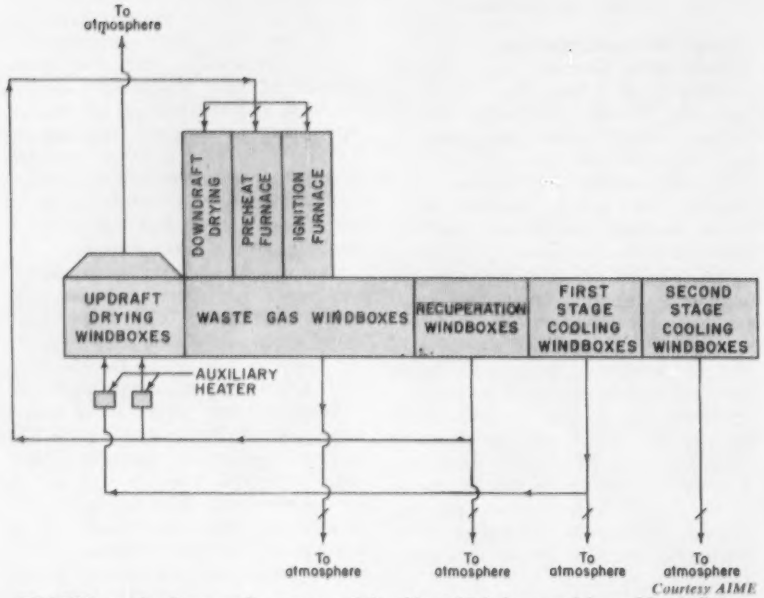
The induction-type furnace makes use of the material to be heated as the secondary coil of a transformer; the primary coil is connected to the supply. Electronic or high-frequency induction furnaces are designed to heat only the shell of material, as in the case-hardening of gears.

This article is excerpted from "Solids-Gas Contacting—Close-Up of a Key Tool in Metallurgy" (E&MJ, July 1956), by Dr. Raymond E. Vener of Catalytic Construction Co., Philadelphia, Pa. In addition to the material on which the above article is based, Dr. Vener's article contains a complete analysis of solids-gas operations outlined on p 106.

The Growing Art

WITH THE TAPPING of low grade iron ores, there is a new surge of interest in ways and means to prepare beneficiated ore for the steel makers. Because beneficiation has required grinding, feed preparation must include agglomeration.

We have broken agglomeration into two parts: First the firing of the pellets showing how four different companies came up with different answers for basically the same prob-



Courtesy AIME

GRATES on the Reserve furnace are 6 ft wide, 168 ft long and have 28 windboxes.

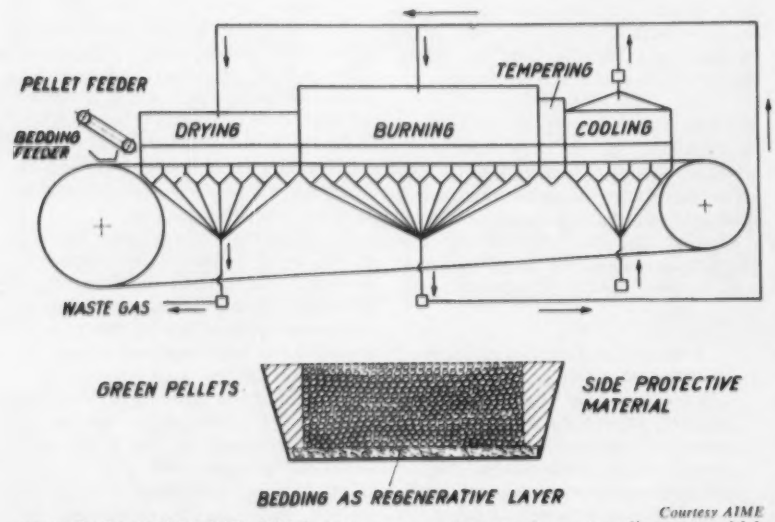
At Reserve

AT SILVER BAY, MINN., six downdraft continuous grate furnaces at Reserve Mining Co.'s E. W. Davis Works, are producing 15,000 to 16,000 tons of taconite concentrate pellets per day although designed capacity of the plant is only 12,000 tons. These pellets for the steel makers contains about 63% iron and 9.7% silica. Let's take a close-up of the machine that makes them, the downdraft continuous grate furnace, and see how it operates.

Operation

Coal coated balls of taconite concentrate (details on balling on p 117), are fed onto grate by vibrating screen feeder which maintains a clean level bed for good airflow and good permeability.

Bed height is a function of grate speed for a given production rate but maximum thickness will give lower



Courtesy AIME

INCLINED CONVEYOR BELT feeds green pellets evenly on traveling gate which passes through down-shaft drying zone, then through the oil- or gas-fired burning zone and finally through the tempering and cooling zones. Magnetite, hematite or limonite or any mixture of these can be pelletized in this system

Lurgi Process

THE PROCESS developed by Lurgi Gesellschaft fur Chemie und Huttenwesen, Germany, (handled by Dravo Corp. in the United States) was originally designed to handle a variety of ores from different parts of Europe. The system incorporates a pelletizing disk (see p 117) and a sintering machine (left) whose temperature can be adjusted to get best results with several ores having different metallurgical characteristics.

Even distribution of pellets is attained by using an inclined conveyor belt. Pellets roll down, slowed by rubber baffles, as the belt travels upward. Fines and broken pellets are carried over the head pulley. An additional benefit claimed for this patented feed system is the strengthening of the pellets.

Sintered pellets and fragments (minus ⅝-in.) are first charged on

Of Agglomeration

lem; and second, some ideas on the technique of rolling the pellets.

While the information for this brief run-down of agglomeration practices, came from many sources, we are particularly indebted to Messrs. Alan English, M. F. Morgan, Kurt Meyer and Fred D. Devaney whose papers given at the New Orleans meeting of the AIME supplied much information discussed below.

It's a Downdraft Continuous Grate Furnace

ignition fuel rates and maximum hot air recuperation within the bed. In actual operation, a 10- to 12-in. bed height gives best results. A typical airflow diagram is shown.

The furnace's 28 windboxes are divided into five zones as follows:

Windboxes 1 to 7. Updraft drying, using 900 deg F air from the recuperation and first stage cooling zone, prevents moisture from condensing on the balls in the bottom layers of the bed. To much moisture causes balls to collapse under weight of balls above resulting in an impermeable bed, low burning rates and too many fines.

Windboxes 8 to 11. Downdraft drying and preheating use recuperated 900 deg F air in two sections of a large ignition furnace. No. 6 fuel oil is used to raise recovered air temperature to 1,400 deg F for drying and 2,000 deg F for preheating.

Windboxes 12 and 13. Recuperated 900 deg air is heated in third section of the furnace using No. 6 fuel oil, to 2,350 deg F for final ignition.

Windboxes 14 to 22. Burning and recuperation.

Windboxes 23 to 25. First stage cooling.

Windboxes 26 to 28. Second stage cooling.

Burning and cooling is accomplished by pulling large volumes of air through the bed. Temperatures in recuperating windboxes are about 1,250 deg F and must be lowered to 900 deg F because of the type of fans used. Temperatures of about 900 deg F are also obtained in first stage cooling. In second stage cooling, air temperatures are about 700 deg F and this air is not used.

Pellets, discharged at 600 to 700 deg F are water cooled and screened before loading or stockpiling. In practice the product passes over a 4-in. grizzley and oversize is reduced by a single roll crusher. The minus 4-in. material is run over a vibrating screen. Undersize from the screen (3/16-in.) is classified and plus 28 mesh is the product. Minus 28 mesh is handled by a fines recovery system. Clinkers larger than 1½-in. are quenched to keep them from burning the belts.

Heat Balance

Total Btu input per ton of pellets		
Fuel oil	420,000	(29.0%)
Propane gas	3,000	(0.2%)
Anthracite	860,000	(59.3%)
Exothermic reaction	166,000	(11.5%)
Total	1,449,000	(100 %)
Total Btu loss per ton of pellets		
Pellets	253,000	(17.5%)
Updraft hood exhaust	284,000	(19.6%)
Waste gas fan exhaust	476,000	(32.8%)
Loss and unaccounted	436,000	(30.1%)
Total	1,449,000	(100 %)

Combines Up- and Downdraft Sintering

the pallets. This heated material helps preheat the air in the updraft zone and protects the pallets in the downdraft zone.

Side walls are protected by a special layer of fines recirculated from the discharge end of the machine. This layer of fines also prevents excessive amounts of hot gas from flowing up or down through the edges of the bed because it is denser than the rest of the bed.

Pellets are dried by air which has been preheated by cooling fired pellets toward the discharge end of the machine plus gas from the windboxes at the burning section.

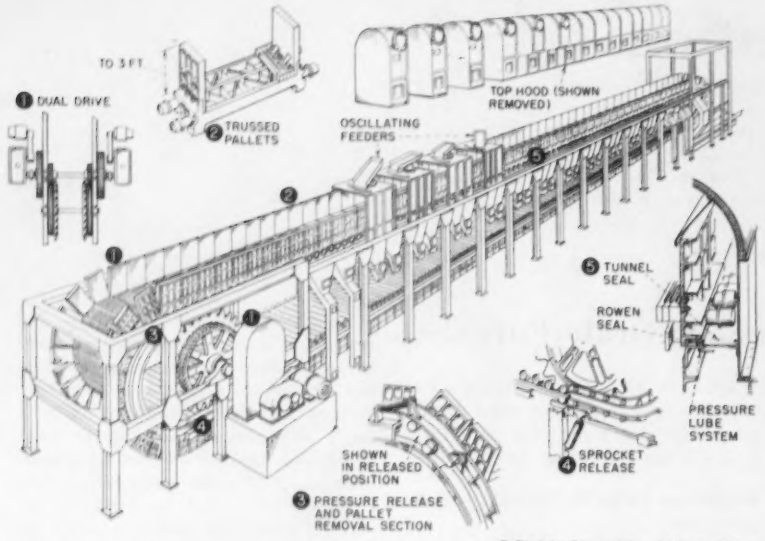
In burning the pellets, only gas or oil is used with no fuel incorporated in the pellets. It is claimed that this permits closer regulation of burning and after actual hardening temperature is reached it can be maintained for several minutes. This is a downdraft operation with gases going to waste after passing through the drying zone. An interesting feature is the use of valves on one or two windboxes which can be closed after the final temperature is reached, stopping the flow of gas. This is said to help produce stronger pellets.

Updraft cold air is used for cooling the pellets. Air thus heated is recirculated through the drying zone at feed end of the machine.

Magnetite, limonite or hematite or any mixture of these can be pelletized in this system. First plant using this process in this hemisphere, was a 1,200 tpd unit built for Inco at Copper Cliff, Ont.

This material was based on a report on a paper presented by Dr. Kurt J. E. Meyer at the New Orleans meeting of the AIME.

PROTECTIVE LAYER of minus ⅝ in. material was first used in experimental sintering pans.



© Dwight Lloyd Div., McDowell Co.

PALLETS are 6 ft wide; the machine has 28 windboxes in 224-ft length.

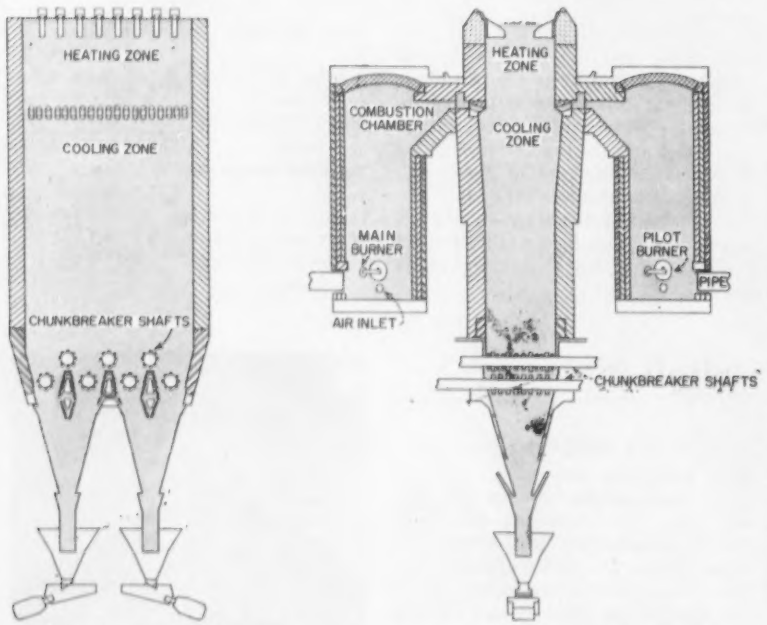
At Marquette

AGGLOMERATING practice at Marquette Iron Mining Co.'s Eagle Mills, Mich., plant is a third variant on the main theme of hardening iron concentrates for the blast furnace.

Coal coated, rolled pellets are fed carefully to the sintering machine. Depth of the bed on the sintering machine is 36 in., and six layers of material are fired at once; a 4-in. layer of fired pellets, a layer of ignition coal, and four 8-in. layers of green pellets from the balling disk. The grate travels at about 30 in. per minute. Pallets are 6 ft wide, 2½ ft long with 3-ft sides.

The 224-ft length of the machine has 28 windboxes (168 ft). Ignition takes place at the feed end, downdraft with propane as the igniting agent. Firing is updraft followed by updraft cooling and downdraft cooling.

Gases from updraft cooling are re-



SHAFT FURNACE at Erie is rectangular, 6 ft wide, 14 ft long and 45 ft high.

At Erie

enters the shaft proper through a series of ports and rises up the upper portion of the furnace, where the pellets reach a temperature in excess of 2,400 deg F. Pellet temperatures higher than combustion chamber temperatures are reached because the furnace atmosphere is strongly oxidizing and the magnetite is almost entirely converted to hematite with the liberation of about 207 Btu's per pound of iron.

This furnace is unique in that, with the exception of a few inches at the top of the furnace, pellets are always hotter than ascending gases. Top gas temperature is normally about 300 deg F.

Pellet surfaces are cooler than their interiors, which creates partial fusion conditions in the interior but not at the surface. This is important, as it lessens any tendency of the pellets to stick together and insured satisfactory material flow.

Heat gradient in the upper part of the furnace is very sharp. For example, incoming green balls will have a temperature, depending on the season, from 35 deg F to 60 deg F and within a distance of approximately 10 in. they will have reached 2,400 deg F. The balls will remain at this temperature until they reach the ports carrying in the air from the combustion chambers. Below these ports the pellets are progressively cooled by the upcoming air admitted at the chunk

ERIE MINING Co.'s shaft furnace is producing about 30,000 tons of pellets a day containing 63% iron, each month with a Btu consumption of 753,680 per ton of pellets. This is how the furnace is operated.

Operation

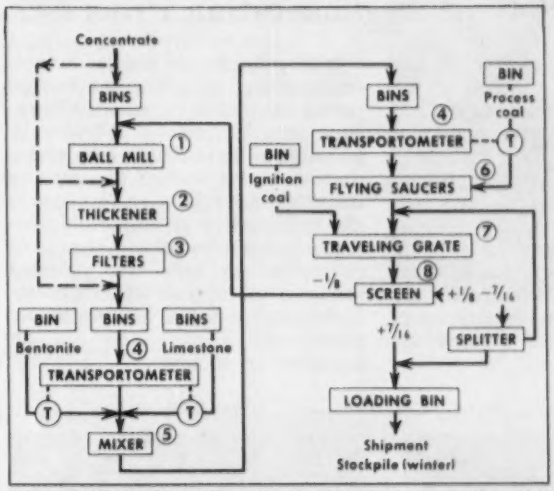
THE FURNACE OPERATES on a counterflow principle. Descending pellets are heated in the upper shaft by rising gases from the combustion chamber and by preheated air. Indurated pellets below the ports are cooled by an uprising current of air blown into the furnace at the level of the chunk breakers. About 35% of the total air is admitted to two combustion chambers, one on each side of the furnace where it is heated to a temperature of approximately 2,350 deg. This hot air

They Use an Updraft-Downdraft Sintering Machine

turned to the firing zone. With updraft firing, the temperature at the grate bars does not exceed 500 deg F although elsewhere in the bed temperatures may reach 2400 deg. Gases from the updraft firing are collected in four Rotoclones and dust is separated and returned to the ball mill.

Pellets are not upgraded in the firing process. Weight is about 110 lb per cu ft, porosity about 30%. Finished pellets are given hardness tests and screened before shipping as shown on the flowsheet right.

Marquette Iron Mining Co. is obtaining about 3500 tons of jasper per day from its open pit mine at Republic, Mich., upgrading the 35% iron ore by flotation and sending a 65% concentrate to its pelletizing plant 27 miles away at Eagle Mills, Mich. On October 3, 1956, the first load of pellets, about 4,500 tons, was shipped.



PELLETIZING PLANT at Eagle Mills includes balling disks (shown above as "flying saucers") to roll pellets for sintering.

LEGEND

1. Hardinge Tricone Mill 11 ft 4 in. x 10½ ft
2. 30-ft Dorr-Oliver thickener
3. Two 7-disk Eimco Agidisc filters
4. Transportometer actuating Transporto-feeders T
5. Pekay mixer Muller
6. Four 18-ft balling disks
7. Dwight-Lloyd updraft traveling grate 224 ft long, 6 ft wide
8. 5 x 14-ft Simplicity double deck vibrating screen

Pelletizing Is Done in Shaft Furnaces

breaker level and are discharged at the bottom at a relatively cool temperature.

Temperature of discharge varies with the operating rate of the furnace and the amount of cooling air. At a moderate production rate, pellet temperature will be about 300 deg; at maximum rate 550 deg F; however, adequate cooling means are provided for belt handling.

Chunk breakers at two levels in the furnace are water-cooled shafts on which mounted tooth-like projections break up descending clusters. They also regulate flow down the shaft.

Discharge openings are free to the air and loss of air through these openings is held to 3 to 5% by restricting the diameter of the discharge pipes. This design eliminates need for mechanical devices for minimizing the air loss.

Cooling air is admitted to the furnace through the louvre-like devices, having long, slot-like openings, as shown in the drawing.

Near the feed line of the furnace are 8 chrome-nickel divider plates on each side, spaced about 18 in. apart. They divide the down-coming, and as yet, still unfired pellets, into zones. Passage of air is always greater near a wall and such dividing plates may be said to furnish additional wall area. They help secure more uniform heating of green balls and prevention of masses of consolidated material which have lost most of their pellet structure.

Heat is supplied to the combustion chambers by a light fuel oil or a heavy residual oil such as Bunker C. If high grade magnetite concentrates are used, or if the furnace is operated at a moderate rate, no other fuel is required. If the furnace is operated at maximum capacity, it's expedient to add about 10 lb of coal to the filtered concentrate impregnating the entire ball structure. This insures kindling of the magnetite giving a more uniform heat distribution over the upper part of the furnace charge.

Air required is very close to the theoretical amount required for heat interchange, taking into consideration the weight of the pellets, their specific heat and the weight of the air blown and its specific heat. Normally the amount of air so blown exceeds the theoretical by a matter of 5 to 10%.

In a 6x14-ft Erie furnace producing 1,000 tpd of finished pellets, 21,000 cfm is blown in. Air pressure required is a function of pellet quality, but will average at this rate, about 6 psi. If the furnace is driven at the rate of 600 tpd, the operating air pressure is in the order of 3 psi.

Capacity of a standard 6x14-ft furnace has increased much beyond 600 tpd regarded as theoretically possible. Better knowledge of the furnace and improvements in design have raised capacity to more than 1,200 tons per 24-hour day of finished pellets. This increase has come with a marked trend towards simplicity in furnace design and with added ease of operation.

Correct feeding of the pellets onto the stockline of the furnace is important. Balls must be deposited evenly over the surface of the bed to secure a definite pattern and this cycle must be so regulated that green balls are deposited on the charge at about the time that the heat line has advanced to one or two-ball depths below the top of the furnace. In the Erie furnace, the feeder traverses a rectangular path and spreading the balls out by means of a flipper at the end of the conveyor. Time required for a complete traverse is from 1½ to 4 min, depending on feed rate. The feeder is so designed that exactly the same number of balls will be laid down in a definite time interval, whether the feed belt is advancing or retracting. The feeder slows down its rate of travel across a low area in the bed, and deposits a heavier load of balls.

Furnace discharge is screened and all material finer than minus 3/16-in. is reprocessed.

Information on Erie Mining Co.'s pelletizing practice was excerpted from the paper, "Pelletizing in a Shaft Furnace", presented by Fred D. Devaney at the February 1957 meeting of the AIME in New Orleans.

Numerous Ways of Forming Pellets Provide A Wide Variety of Agglomeration Processes

TWO OF THE MOST IMPORTANT key points in the forming of pellets are the method of balling the concentrate and additives to be used if any.

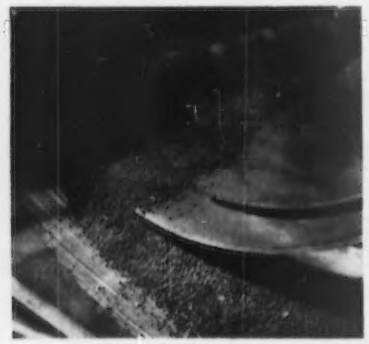
Methods of balling that have been studied include the use of balling drums, vacuum units, extrusion presses, compacting machines, pelletizing disks and even large scale cookie cutters. Of them all, the rolling drum and the pelletizing or balling disks, are most widely used in new plants today. Typical installation of each is described below.

Balling drums are simpler in construction and operation but because pellets are rolled to many different sizes, drums must be followed by screening of some kind to keep undersize out of the feed to the sintering unit. Care must be taken to maintain the drum surface to keep balls from sliding. Disks offer closer control of pelletizing and have been operated without a screening device. Proponents of the disk claim that it forms harder pellets and indeed; some use no strengthening additives.

On plastic ores, which pretty well excludes iron ores, the extrusion press gives a satisfactory although inferior pellet, and has production limitations.

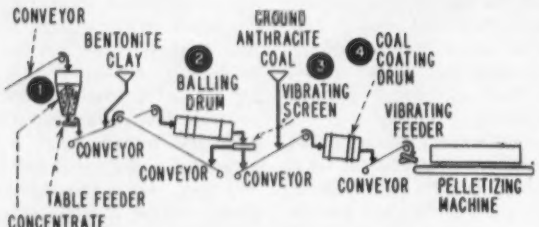
Concentrate size distribution is an important factor in balling. Most operators are handling material ground to about 150 mesh with 65 to 85% passing 325 mesh. In some cases the concentrate or a portion of it, is reground to get proper size distribution.

Additives include binders and combustible materials. Bentonite is the preferred additive for strengthening although starch has been tried and is reported to contribute to the pellet's wet strength but not dry strength. At



CONCRETE LINED 9x13-ft balling drums form pellets at Reserve Mining.

FULL SIZE PELLETS are coal coated in this 8x12-ft drum.



PELLETIZING PLANT
SILVER BAY OPERATIONS

LEGEND

1. **Concentrate storage bins.** Three steel storage bins for each pelletizing machine (6 machines). Capacity 450 long tons each.
2. **Balling drums.** Three 9x30-ft long concrete-lined steel balling drums per pelletizing machine. Each of the three drums has a capacity of 30 to 40 long tons per hour, and rotates at about 10 to 11 rpm.
3. **Vibrating screen.** Undersize goes back to balling drum, oversize goes to the coal coating drum.
4. **Coal-coating drum.** Three 8-ft diameter by 12-ft long coating drums for each pelletizing machine. Capacity of each drum is 30 to 40 long tons per hour, and rotation about 10.5 rpm.

Balling Drum

PROBABLY the most widely practiced method of forming pellets to feed the agglomerating furnace, is the balling drum. Each operator has his own refinements of the simple basic process; here are the ways that Reserve Mining (flowsheet left), Silver Bay, Minn., and Erie Mining Co., Hoyt Lakes, Minn., handle the problem.

At Reserve, concentrates go to three 9x30-ft concrete-lined steel balling drums with capacity of 30 to 40 long tons per hour. Bentonite added at the rate of 9 lb per long ton of concentrate adds strength to the dry pellets before burning. Rotation of the drums at 10 to 11 rpm produces pellets which go to vibrating screens. Undersize goes back to the head of the balling drums, while oversize (plus ⅜-in.) goes to three 8x12-ft coal-coating drums where 60 to 65 lb of fine anthracite per ton of pellets is added. Each drum has a capacity of 30 to 40 long tons per hour, and rotates about 10.5 rpm.

At Erie, Fred D. DeVaney of Pickands Mather & Co., states that a similar drum was "developed by the invention of a reciprocating cutter bar which controls the thickness of the cake on the inside surface of the balling drum yet gives a surface which is relatively rough . . . so that the balls being formed will roll rather than slide."

Balls must be formed slowly for high density should be sized carefully to keep fines out of the furnace. Erie uses a trommel at the end of the drum with ⅝-in. openings. Undersize balls are conveyed back to the feed end of the drum.

Marquette Iron Mining's Eagle Mills plant, pulverized limestone is added for increased strength.

Bentonite unquestionably increases both wet and dry strength and in addition is said to permit fast, high temperature drying with minimum degradation. Amount added is usually about ½% by weight of the pellet charge. One operator reports that this amount increases the dry strength of the pellet from 0.72 psi to 4.79. The added strength comes from holding the particle in a slag bond.

Composition of bentonite is variable but the Wyoming type is most sought. This contains about 22% alumina, 64% silica plus lime, soda and ferric oxide. In some plants soda ash is added with the bentonite to aid in dispersion.

Combustible material added in a mixture with the concentrate or as a coating. In the Lurgi process, no combustible material is added to permit closer control of the burning.

At Reserve Mining's Silver Bay plant, anthracite fines are used and No. 6 fuel is added to complete thermal requirements. Plants using bituminous coal add 4 to 8% by weight of the pellet charge. Actually, coke breeze or almost any form of carbon would be satisfactory and selection of combustible material depends on the economic situation of the individual plant with respect to source of raw materials.

Courtesy AIME

PELLETIZING DISK is early experimental model of the Lurgi Co. (Germany)

Balling Disk

SOMETHING ELSE IN BALLING was revealed when Marquette Iron Mining Co. opened its pelletizing plant at Eagle Mills, Mich., to treat concentrates from its low grade iron operations at Republic. To roll the pellets, a balling disk was employed. Here's how it works.

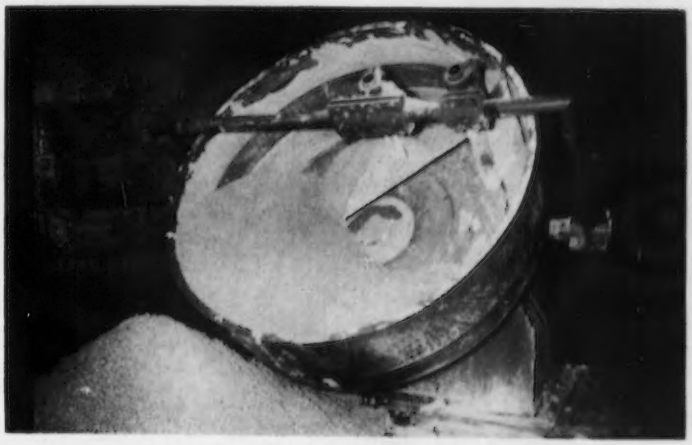
A mixture of ground concentrate, bentonite and pulverized limestone is fed to the balling disk through a chute which drops it in the inside area of the disk. The outer pocket around the rim of the saucer receives process coal to coat formed pellets.

Sitting at an angle, the disk rotates clockwise at about 7 rpm. The angle of the disk may be changed to vary pellet size; the flatter the angle the bigger the pellets, the smaller the capacity.

As the concentrate mixture drops into the center of the ring it is carried down to the inner ring of the saucer where partly formed pellets are cascading down. These pellets grow and new pellets are formed by this action and the mass is lifted in the rotation until it reaches a point near the top of the ring and starts to cascade again. The whole operation is continuous.

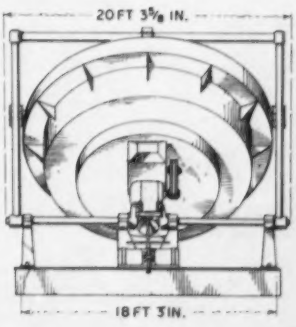
When sufficient mass is built up, formed pebbles, from ⅜- to ½-in. in diameter overflow into the process coal in the outer ring, where they receive a thorough coating which adds about 5% to the pellet weight.

Coated pellets overflow the coal ring just beyond the bottom of the balling dish where a conveyor belt takes them to the sintering machine. Capacity of the disk is about 30 tph. At Eagle Mills, four disks are used at full plant capacity with one rolling slightly smaller pellets than the other three.

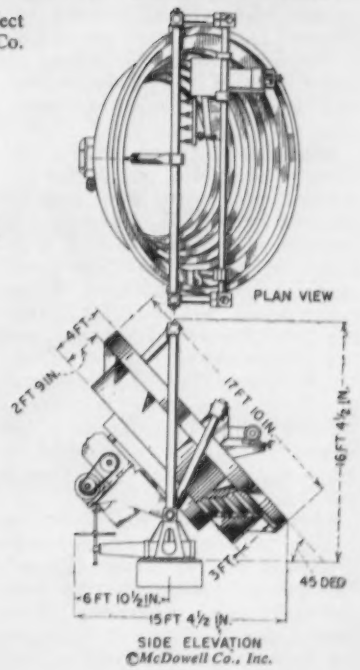


PELLETIZING PAN has been the subject of experimental research at Hardinge Co.

BALLING DISK
EAGLE MILLS PLANT
MARQUETTE IRON MINING CO.



REAR ELEVATION



SIDE ELEVATION

©McDowell Co., Inc.

The Rise of Chemical Metallurgy

THE STEADILY WIDENING USE of chemical-metallurgy rates as one of the most important developments in the history of the mining industry. The techniques being brought into play have been and will be responsible for making productive, metal sources that might have remained completely useless.

In the present surge of interest in chemical metallurgy, nickel, cobalt, copper and uranium come first to mind. Few people realize however, that between the bauxite mine and the aluminum reduction plant stands a huge chemical-metallurgical industry for the production of alumina. And how many recall that in the 40's, the old Texas City tin smelter was using pressure-temperature techniques to win tin from ores previously considered untreatable?

Plants with flowsheets like those shown on this and the following pages will soon be unlocking vast sources of complex, low grade ores like the world's extensive laterite deposits. These flowsheets are the result of technical pioneering extensive research, disappointments and determination. For the progress they represent we owe thanks to companies like Freeport Sulphur, National Lead, Howe Sound, Sherritt Gordon and innumerable uranium companies. Nor should we forget the work of men like Dr. Forward and other scientists in Government and university.

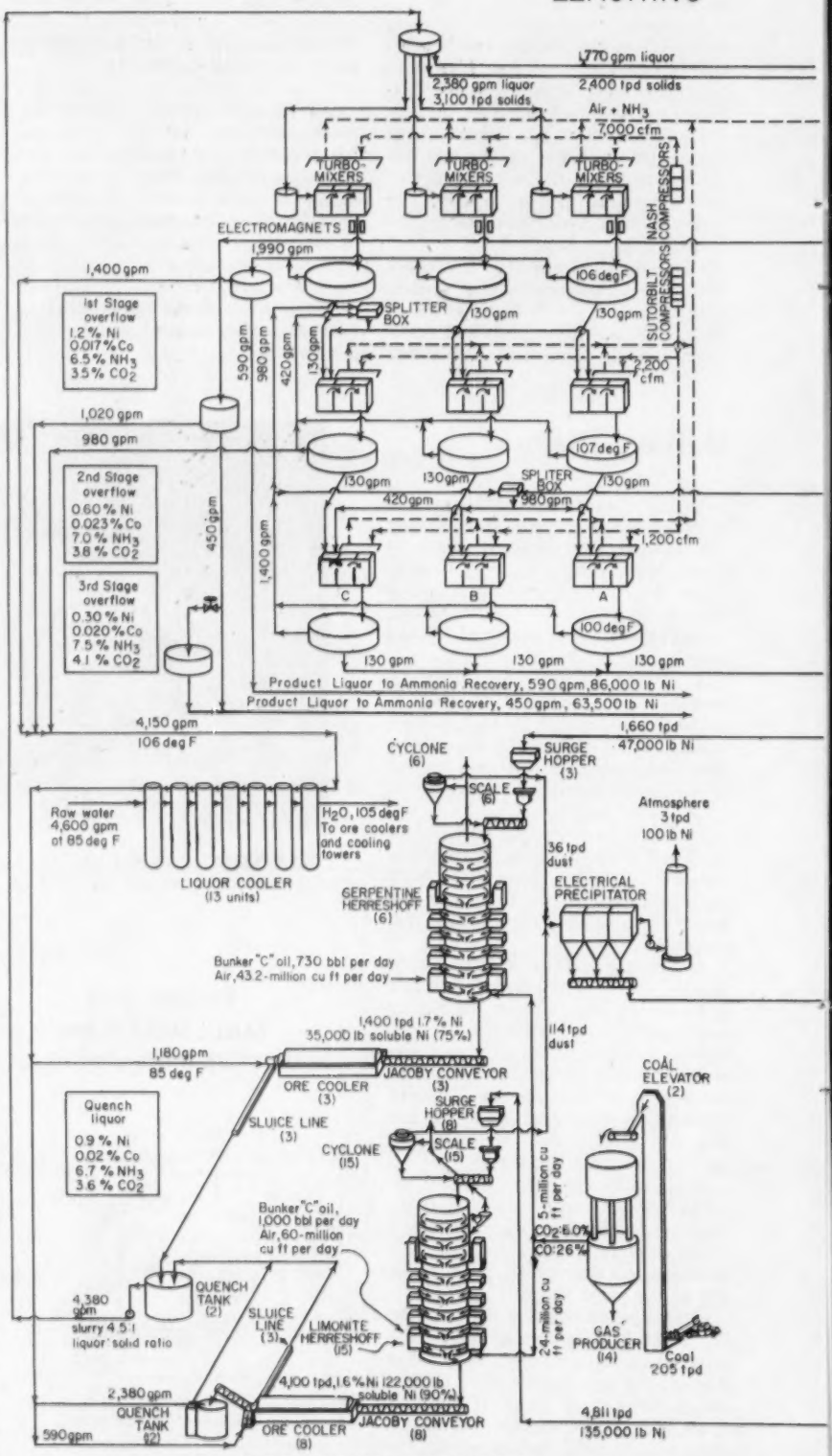
Nicaro (leaching and washing flowsheet at right) was one of the first chemical-metallurgical plants. Built and operated for the U. S. Government by Freeport during World War II, it extracted nickel and cobalt from Cuban laterites. After a shutdown, it was reactivated in 1949 by Nickel Processing Corp. (owned by National Lead and Cuban interests) acting for the U. S. Government. Recently completed expansion enables the plant to produce 50-million lb of nickel a year despite the fact that the manner in which the nickel occurs in the ore is still unknown.

On the following pages you will find the flowsheets of Howe Sound's Garfield plant and Sherritt Gordon's Saskatchewan plant plus the basic flowsheets used separately or in combination by a score of companies for the recovery of uranium.

NICKEL PROCESSING CORP.

Analyses and quantities shown on this flow sheet are

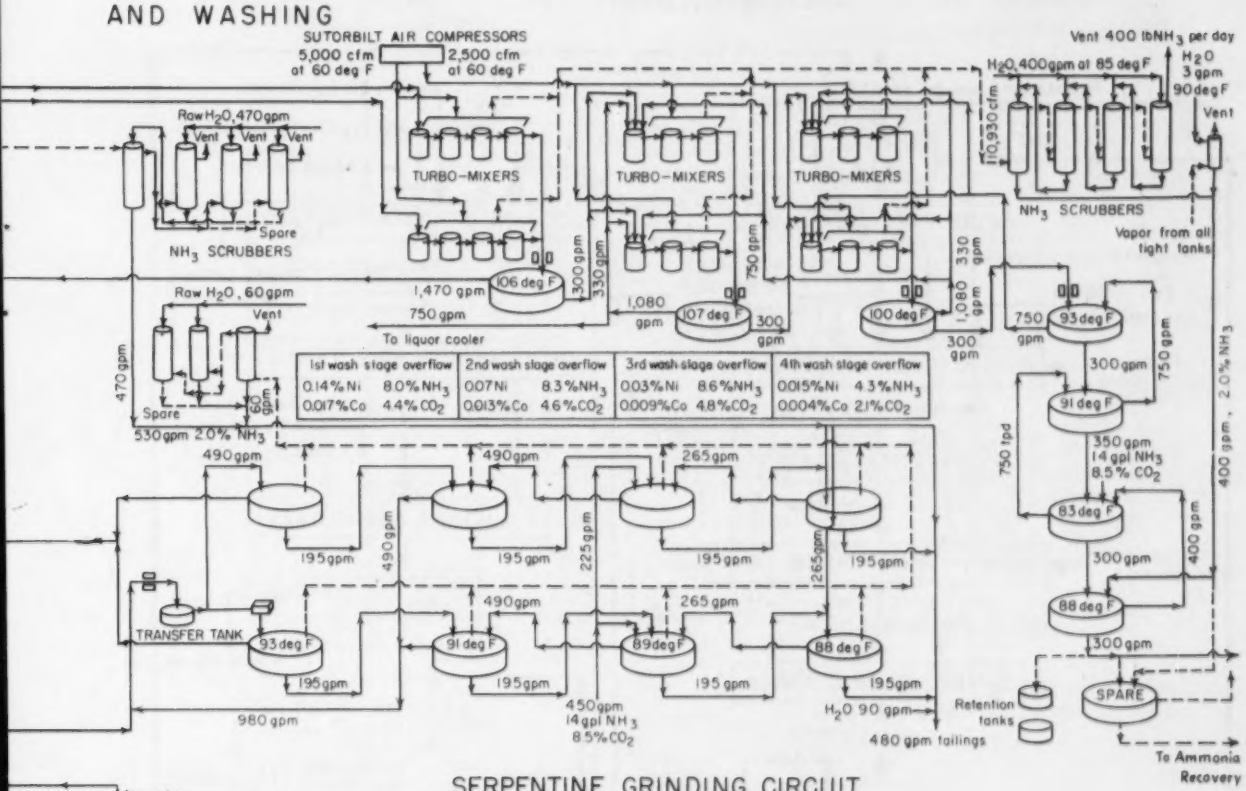
LEACHING



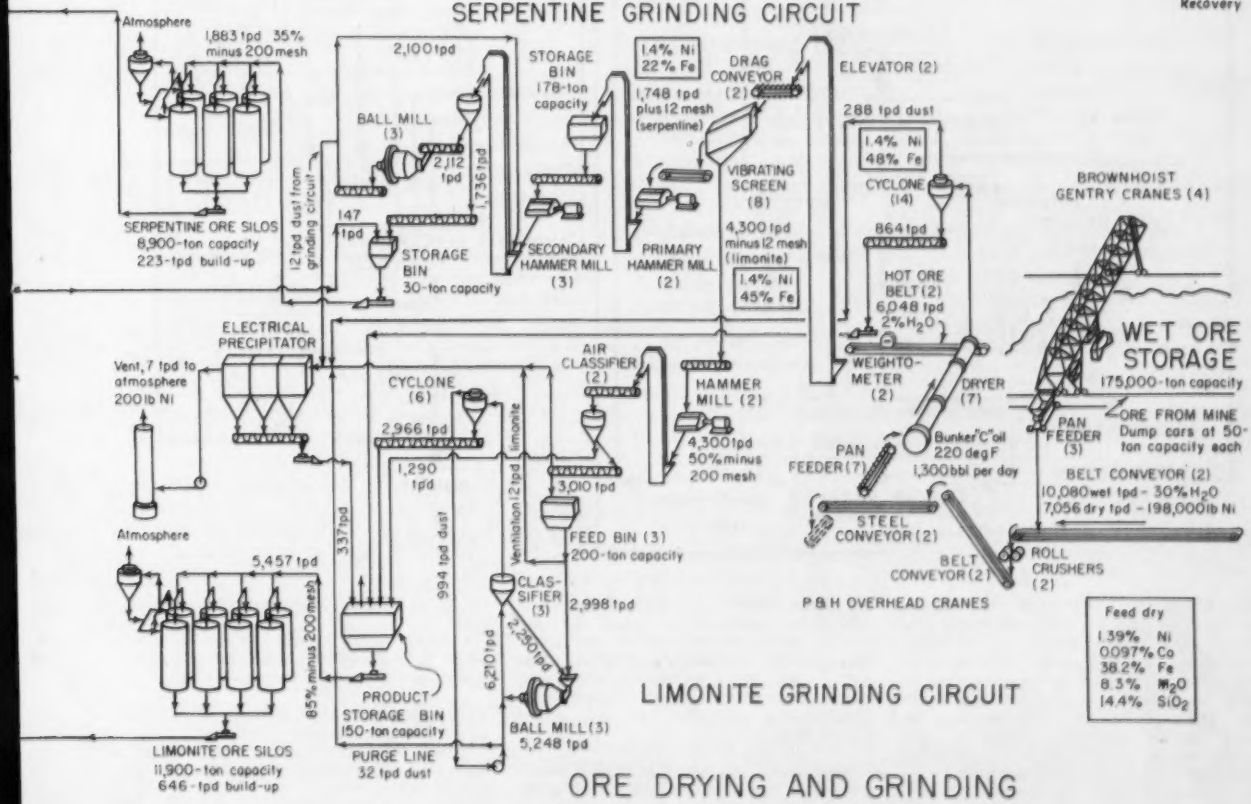
NICARO PLANT

approximations only and subject to variation over a wide range

AND WASHING



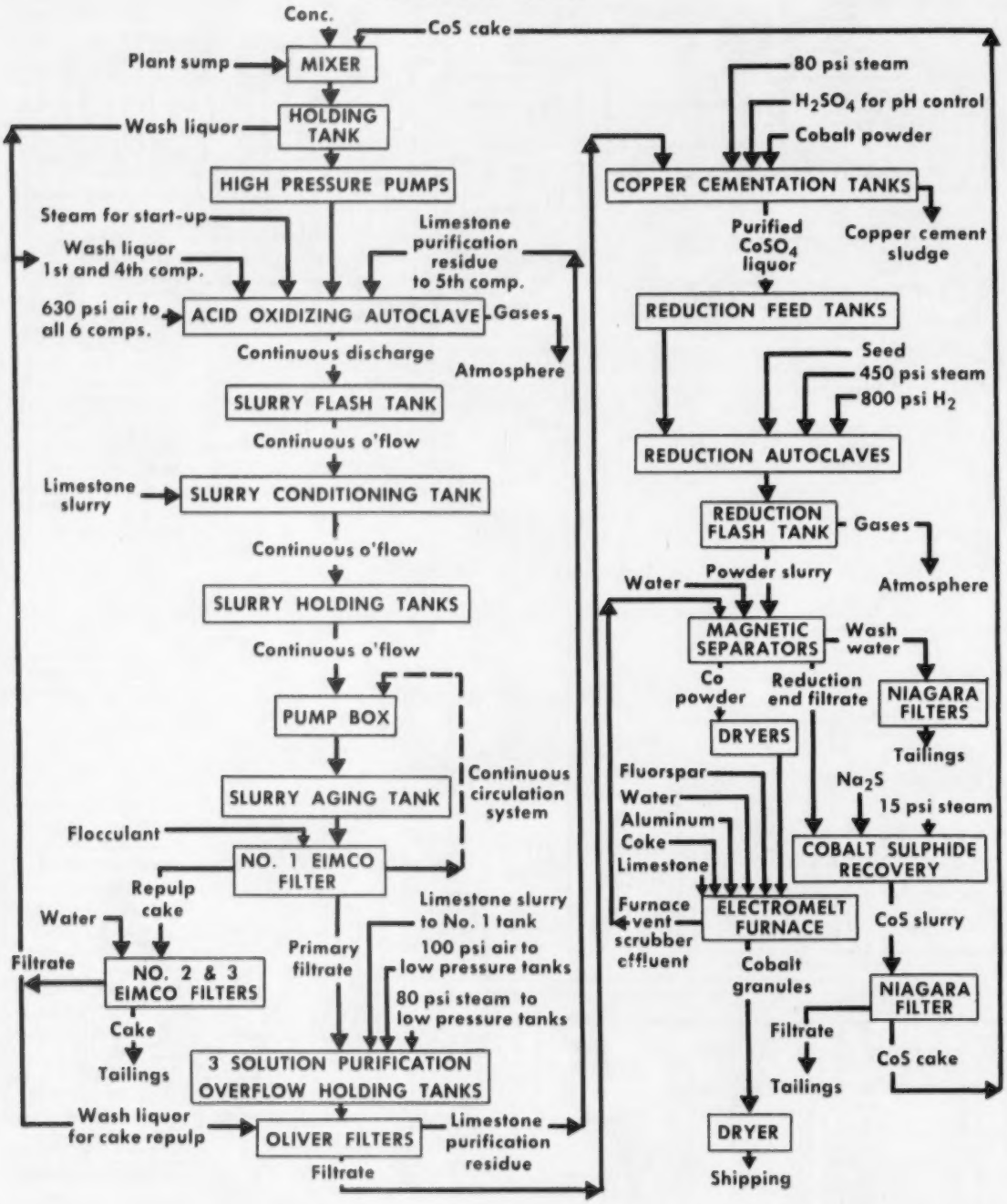
SERPENTINE GRINDING CIRCUIT



LIMONITE GRINDING CIRCUIT

ORE DRYING AND GRINDING

CALERA MINING CO.
Garfield, Utah



Ore which is concentrated to become the feed for the Garfield refinery is obtained from Calera Mining Co.'s Blackbird mine. The ore comes from two main ore zones at the mine and is described by E. B. Douglas, manager of Calera's Blackbird Div., as follows: "Chicago ore of high sulphide content, consists of unusually vuggy pyrite, pyrrhotite and ore minerals, chalcopyrite and cobaltite.

"Massive sulphides are not the rule (in the Brown Bear ore zone) but occur in only a few spots and the cobalt in particular is finely disseminated in the schist. The sulphide minerals are cobaltite, chalcopyrite and pyrite. Pyrrhotite, which constitutes much of the sulphide mineral in the Chicago, has not been observed in the Brown Bear."

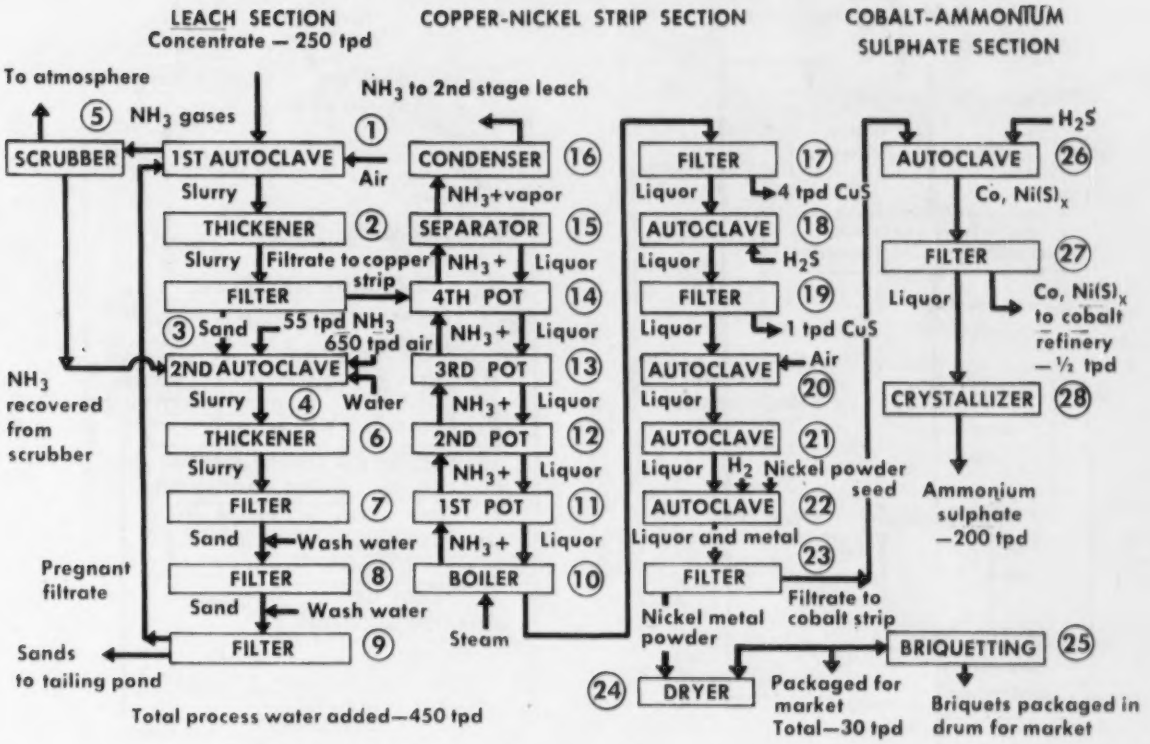
Concentrates. Analysis of concentrates arriving at the Garfield refinery is given by J. S. Mitchell, plant manager, as follows:

Cobalt 17.50%; iron 20.00; arsenic 24.00; sulphur 29.00; nickel 1.00; copper 0.50; insoluble 5.00; moisture 12.00.

Final Products. Mr. Mitchell gives the analysis of final products as follows:

Cobalt 95.60%; nickel 3.90; sulphur 0.03; iron 0.20; arsenic 0.03; copper 0.02; carbon 0.15.

SHERRITT GORDON MINES LTD.
FT. SASKATCHEWAN, ALBERTA



LEGEND

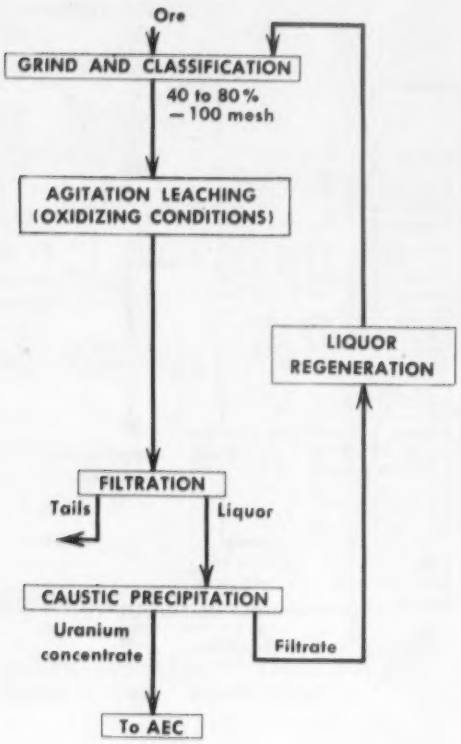
1. Primary leach autoclaves (2), 11-ft dia by 45 ft long, 20% stainless ELC clad. Water jacketed with coolers in shell, partitions, heads, plus internal coils. Agitators—4 each (50 hp)
2. Adjustment thickener. Concrete dome and shell, with one course brick-set-lining over ¼-in. Pyroflex membrane. Autorise. 105-ft dia
3. Adjustment filters, 7 disks, 8-ft 6-in. dia with 650 sq ft cloth. Nylon or Polythene. All wetted surfaces are 304 stainless
4. Secondary leach autoclaves (6), same size and construction as No. 1 above with water coolers in jacket, shell and partitions. 30-hp drive on agitators
5. Conventional gas scrubbing tower to reclaim NH_3 and return gas to process
6. Final thickener is same construction as No. 2 above
7 and 8. Wash filters are disk, 8-ft 6-in. dia with 925 sq ft Nylon or Polythene cloth. All wetted surfaces are 304 stainless
9. Final filter is same as No. 7 and 8 above
10. thru 16. Copper reboil equipment: Pots 11, 12, 13 and 14 are 9-ft dia by 9 ft 6 in. in 316 ELC stainless. Reboiler (No. 10) is 11-ft dia by 30 ft in 316 ELC. Condenser for ammonia vapor is 36-in. dia by 17 ft of carbon steel
17. Sweetland filter press to remove copper sulphide, runs at 50 psi, is 36-in. dia and lined with 316 ELC
18. Stripping autoclave is 5-ft dia by 26 ft and in 316 ELC
19. Final copper filter is Sweetland, same as No. 17 above
20. Oxidation autoclave operates at 350 deg F and 690 psi. Construction is 5 ft 6 in. dia by 22 ft of 1 34/32-in. type 10% clad 316. Four turbine agitators of 10 hp each
21. Hydrolysis autoclave operates at 465 deg F and 610 psi, is same as above, but with four radial-tip agitators, 10 hp each
22. Reduction autoclave feed tank runs at 400 deg F and 200 to 250 psi. Construction is 8-ft dia by 30 ft long of ¾-in. 20% clad 316. No agitators

    Reduction altoclave runs at 350 to 400 deg F and 350 to 500 psi. It is 6-ft dia by 25 ft long of 1 1/3-in. clad 316. Four 25 hp, radial-tip agitators
23. Wemco screw classifier and horizontal rotary filter, both stainless
24. Direct-fired rotary dryer is 3x30 ft long
25. Sintering furnace is gas-fired, radiant-tube, mesh belt; sinters at about 1,600 deg F briquettes from Kamarek Greaves briquetting rolls
26. Cobalt precipitation autoclave runs at 155 deg F and 5 psi. It is 5-ft 9-in. dia by 18 ft and made from ⅜-in. 316 ELC. Three 15-hp radal-tip agitators
27. Sweetland filter runs at 150 deg F and 50 psi max., same dimensions as Sweetland Filter used in No. 17
28. Crystallizers are triple effect evaporator, that discharge to automatic batch centrifuges with crystals going to direct-fired rotary dryer, then to storage for bagging and shipment

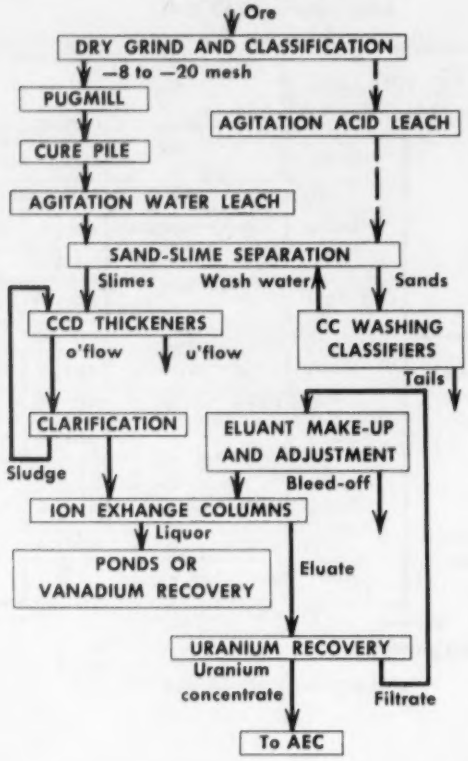
Ore is mined and concentrated at Lynn Lake, Manitoba, to produce two concentrates— low-nickel high-copper concentrate, running 28 to 30% Cu; and low-copper high-nickel concentrate, running 12 to 16% Ni. Lynn Lake ore is a massive pyrrhotite and disseminated sulphide with pentlandite, chalcopyrite, pyrrhotite, pyrite and small amounts of Co-Ni-pyrite.

Finished products from the ammonia leach include: high-purity nickel powder and briquets at better than 90% recovery, high-grade copper sulphide that is shipped to Noranda (although Sherritt has a pilot method to convert sulphide copper to metal), cobalt metal (from batch runs in the pilot plant on cobalt-bearing material from main leach plant), iron oxide tailings, ammonium sulphate and liquid ammonia fertilizers.

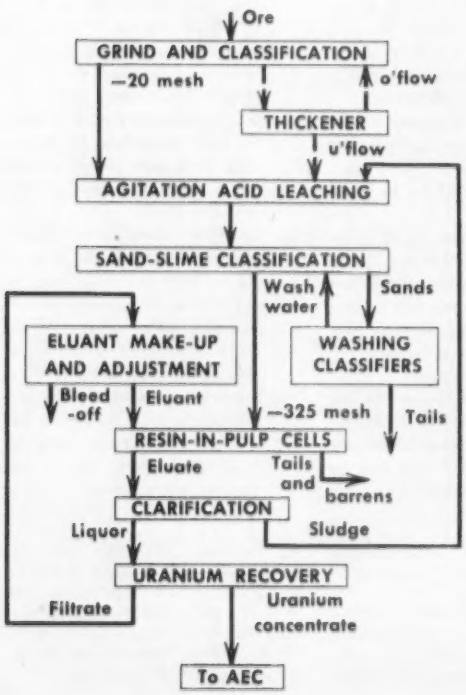
URANIUM RECOVERY
Sodium Carbonate Leach



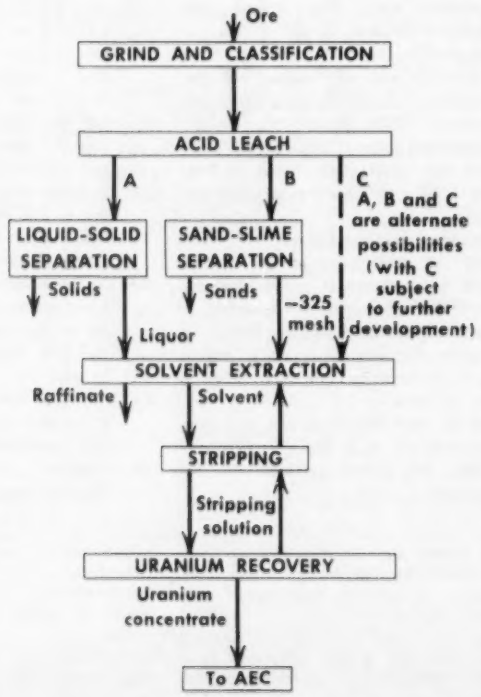
URANIUM RECOVERY
Ion Exchange

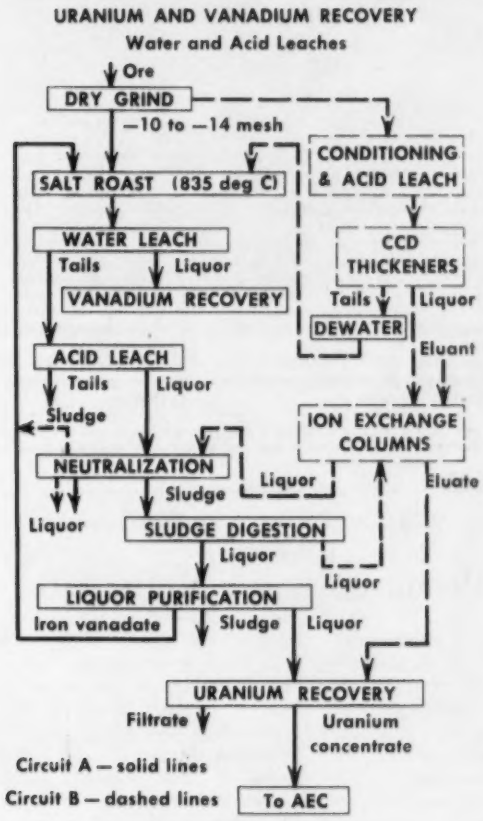


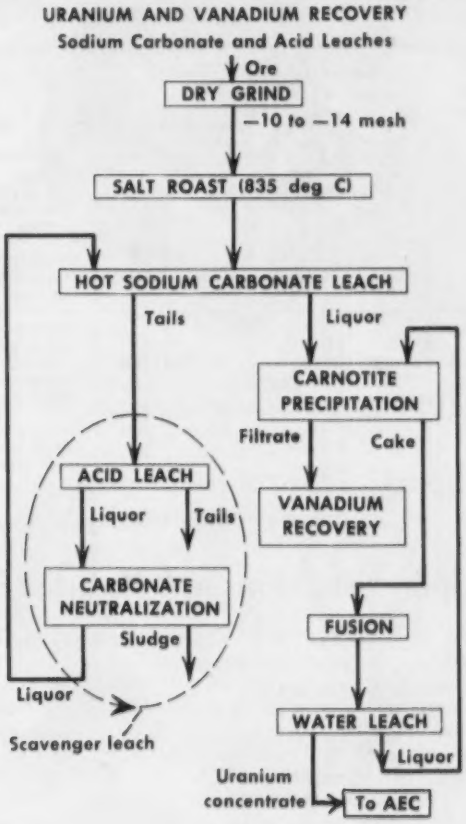
URANIUM RECOVERY
Resin-in-Pulp

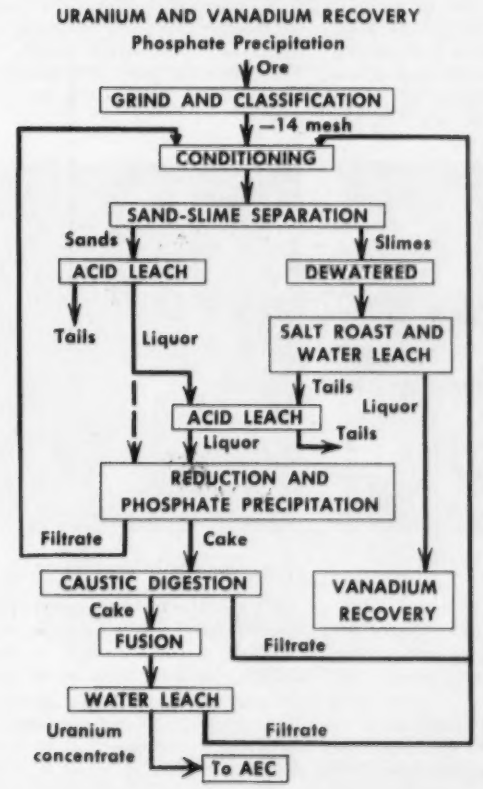


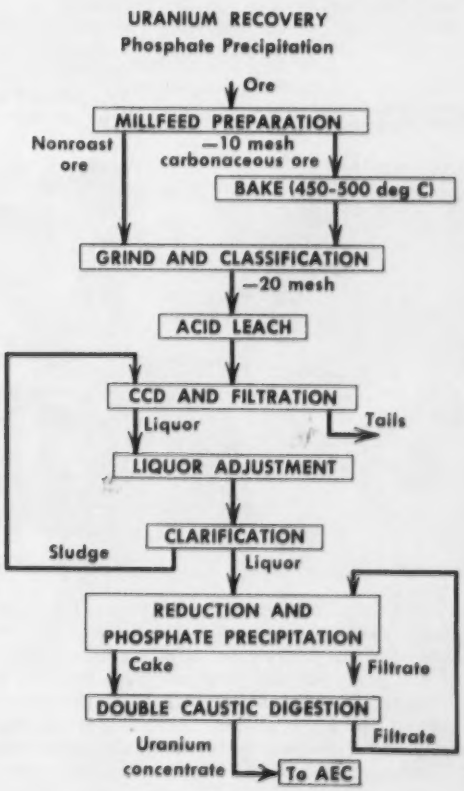
URANIUM RECOVERY
Acid Leach-Solvent Extraction




URANIUM AND VANADIUM RECOVERY
Water and Acid Leaches
Ore
DRY GRIND
−10 to −14 mesh
SALT ROAST (835 deg C)
WATER LEACH
Tails
Liquor
VANADIUM RECOVERY
ACID LEACH
Tails
Liquor
Sludge
NEUTRALIZATION
Liquor
Sludge
Liquor
SLUDGE DIGESTION
Liquor
Liquor
LIQUOR PURIFICATION
Iron vanadate
Sludge
Liquor
URANIUM RECOVERY
Filtrate
Uranium concentrate
Circuit A — solid lines
Circuit B — dashed lines
To AEC
CONDITIONING & ACID LEACH
CCD THICKENERS
Tails
Liquor
DEWATER
Eluant
ION EXCHANGE COLUMNS
Eluate


URANIUM AND VANADIUM RECOVERY
Sodium Carbonate and Acid Leaches
Ore
DRY GRIND
−10 to −14 mesh
SALT ROAST (835 deg C)
HOT SODIUM CARBONATE LEACH
Tails
Liquor
CARNOTITE PRECIPITATION
Filtrate
Cake
ACID LEACH
Liquor
Tails
VANADIUM RECOVERY
CARBONATE NEUTRALIZATION
Sludge
FUSION
Liquor
Scavenger leach
WATER LEACH
Liquor
Uranium concentrate
To AEC


URANIUM AND VANADIUM RECOVERY
Phosphate Precipitation
Ore
GRIND AND CLASSIFICATION
−14 mesh
CONDITIONING
SAND-SLIME SEPARATION
Sands
Slimes
ACID LEACH
DEWATERED
Tails
Liquor
SALT ROAST AND WATER LEACH
Tails
Liquor
ACID LEACH
Liquor
Tails
REDUCTION AND PHOSPHATE PRECIPITATION
Filtrate
Cake
CAUSTIC DIGESTION
Cake
VANADIUM RECOVERY
FUSION
Filtrate
WATER LEACH
Uranium concentrate
Filtrate
To AEC


URANIUM RECOVERY
Phosphate Precipitation
Ore
MILLFEED PREPARATION
Nonroast ore
−10 mesh carbonaceous ore
BAKE (450-500 deg C)
GRIND AND CLASSIFICATION
−20 mesh
ACID LEACH
CCD AND FILTRATION
Liquor
Tails
LIQUOR ADJUSTMENT
CLARIFICATION
Sludge
Liquor
REDUCTION AND PHOSPHATE PRECIPITATION
Cake
Filtrate
DOUBLE CAUSTIC DIGESTION
Filtrate
Uranium concentrate
To AEC

Progress in Motor Design for Mining

NEMA Design	General Operating Characteristics				Intended Usage	Typical Applications
	Locked Torque	Pull-out Torque	Locked Current	Slip		
A	Normal	High	Normal	Low	Infrequent starts with relatively light starting load; long running periods at normal loads with occasional, short duration peak loads; continuous operation at slight overloads under certain conditions.	M-G sets, fans, drill presses, lathes, pumps, grinders, conveyors, machine tools, slusher hoists, compressors.
B	Normal	Normal	Low	Low		
C	High	Low	Low	Low	Infrequent starts with relatively heavy starting load; long running periods at normal loads, limited capacity for peak loads and overload.	Electric stairways, pulverizers, compressors, conveyors.
D	High	.....	Low	High	Intermittent rated: frequent starts with heavy starting load and short operating periods.	Cranes, hoists, winches, valves, elevators.
					Continuous rated: light running loads alternating with frequent momentary peak loads; reversing service.	Punch presses, Tapping machines.
F	Low	Extra Low	Extra Low	Low	Similar to Design B but where extra low locked current is necessary and low torques are acceptable; lack of torque margin restricts overload capacity; imperative that load requirements match the motor rating.	

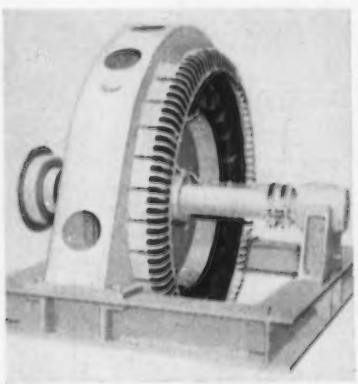
GUIDE TO CORRECT application of squirrel-cage NEMA-design motors for mine and shop.

Proper Selection and Maintenance Promise Longer Motor Life

BEARING TROUBLES and winding troubles are the most common ones which disrupt motor performance in mines, mills and smelters. Recognizing these factors, J. W. Samzelius and R. F. Woll of the Motor Engineering Department of Westinghouse Electric Corp.[1] recommended, first, that a motor be selected which will stand up under operating conditions confronted. The above chart shows operating characteristics of NEMA-design, squirrel-cage motors with applications in mines and shops. Next these engineers set down the following causes of motor failures: 1. Dirt and dust, which damage bearings and insulation. 2. High ambient temperature which affects lubrication, bearings and insulation. 3. Moisture and corrosive atmospheres, which tend to rust and corrode all parts of the motor and may break down the lubricant. 4. Poor lubrication, which causes friction and heat in bearings, and may cause additional heat in the windings. 5. Overload, which may harm bearings and cause excessive heat in the windings. 6. Vibration, which may cause mechanical failure in any motor part.

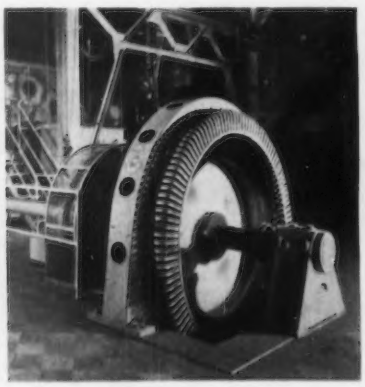
It is suggested therefore that you consult with your motor manufacturer to obtain the design and rating best suited to your operating conditions, and then set up a preventive maintenance system that will recognize the foregoing causes of motor failure and eliminate them. The following pages illustrate motor-design details which enable motors to perform satisfactorily in various applications in the mining field.

[1]From a series of articles on Preventive Maintenance, *Westinghouse Maintenance News*, Vol. XXI, No. 1.



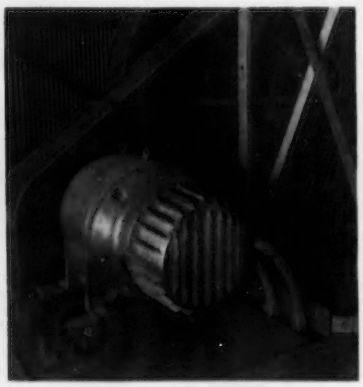
For Grinding Mills

This large low-speed (80 to 450 rpm) synchronous motor will stand up under severe vibration and electro-magnetic forces. Armature and field coil connections are firmly brazed in position. Unit is designed to run long periods without shutdown. Inspection is easy. General Electric Co.



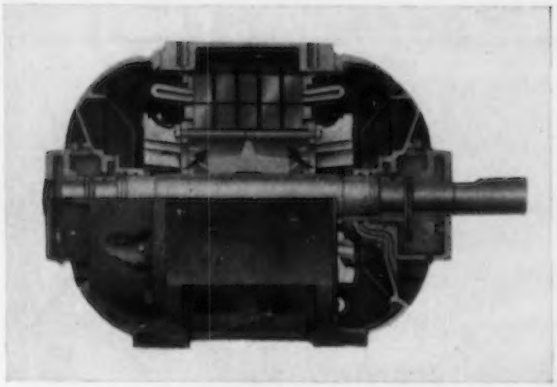
For Grinding Mills

Above 250 hp the synchronous motor is superior to induction motors for grinding because it is cheaper, more efficient and affords higher power factor. New units come equipped with insulation hermetically sealed about coil to stop mechanical and electrical deterioration. Allis-Chalmers.

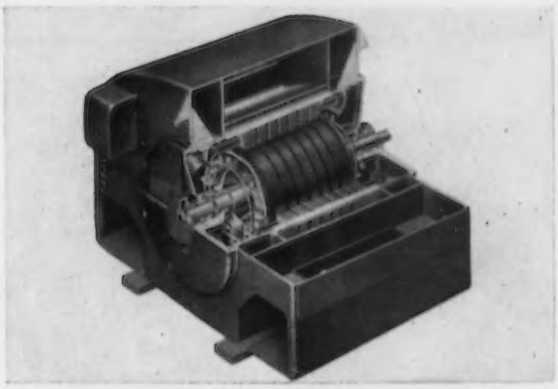


For Rock Crushers

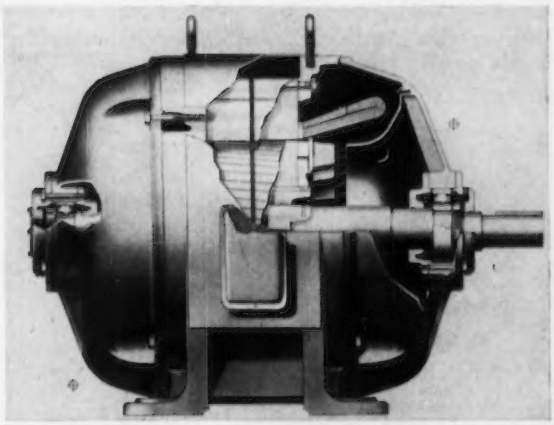
This wound-rotor induction motor is recommended for crushers because of its high starting torque, ability to come up to controlled speed quickly, and fast speed adjustment under high-load conditions. Rotor starting heat is dissipated in external starting resistors. Allis-Chalmers.



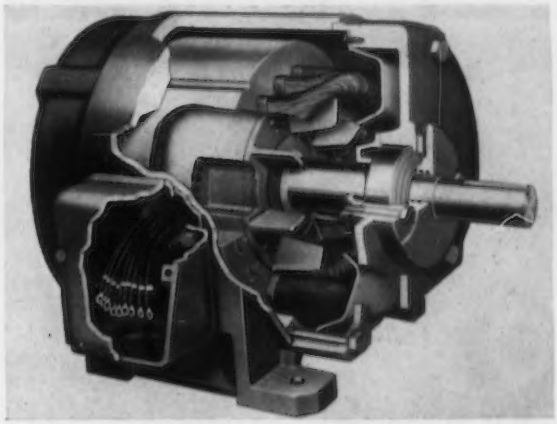
FOR SMELTERS where heat and dust can damage motors, this ac drip-proof motor with twin fans and integral bearing housings offers needed protection. General Electric Co.



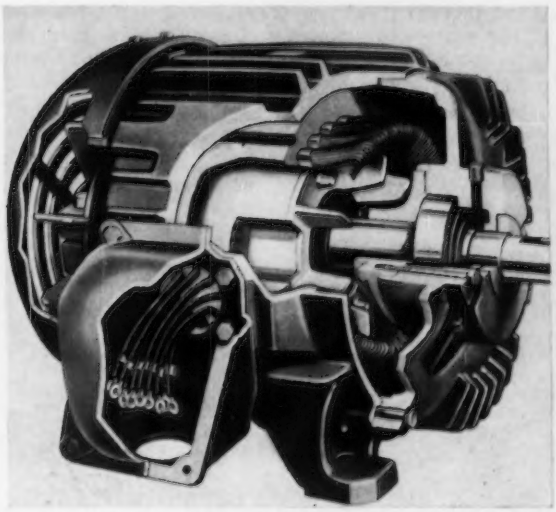
FOR RUGGED OUTDOOR installations, this ac motor features a heavy-gage enclosure, strong high-dielectric insulation, and multiple-seal bearings. General Electric Co.



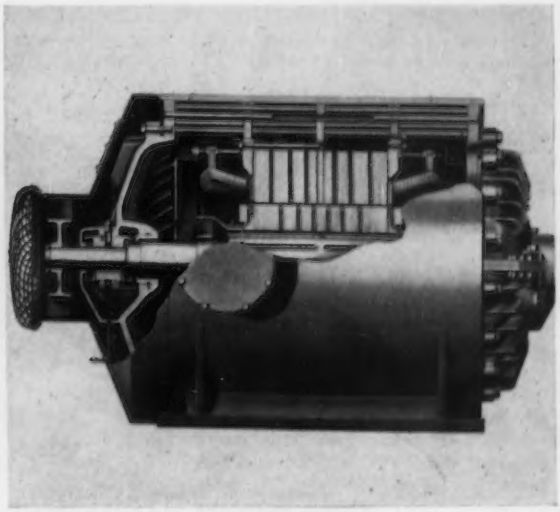
FOR SMELTERS. Splash-proof ac induction motor is protected against corrosive dusts, fumes and vapors. Available, 16 to 800 hp, 450 to 3,600 rpm. Allis-Chalmers.



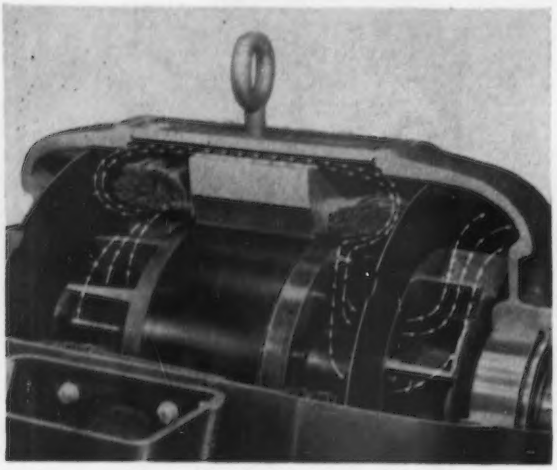
FOR METALLURGICAL PLANTS. Unit offers drip-proof protection against airborne particles. Has underside ventilation. Sizes, ½ to 40 hp, 600 to 3,600 rpm. Allis-Chalmers



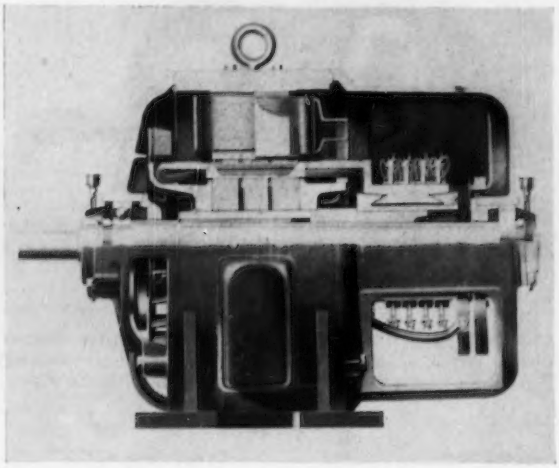
EXPLOSION-PROOF AC MOTOR for dirty, dusty, oily, humid, corrosive and outdoor locations. Motor is cooled with non-sparking aluminum fan. Cooling ribs aid heat dispersal. Sizes, ½ to 30 hp, 600 to 3,600 rpm. Allis-Chalmers.



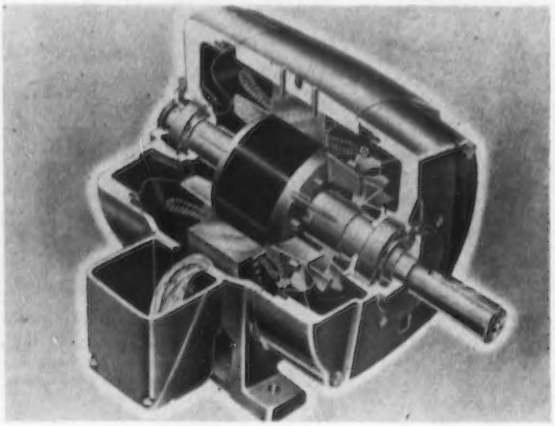
EXPLOSION-PROOF SYNCHRONOUS MOTOR has tube-type air-to-air heat exchanger. Good for plants where light-metal powders, explosive gases, or powdered sulphur may be present. Available in sizes from 40 to 800 hp. Allis-Chalmers.



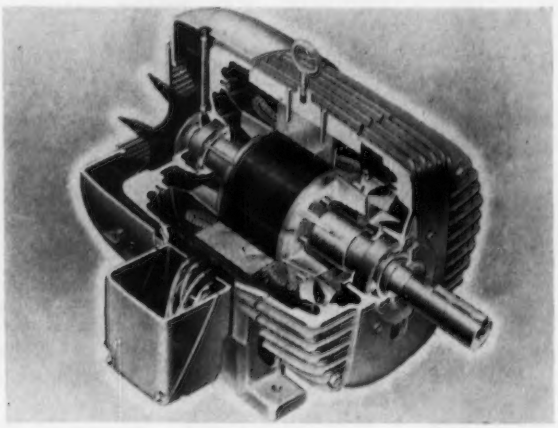
HOT SPOTS are eliminated in this dual-sweep, twin-fan (one pushing, one pulling) motor. Robbins & Myers, Inc.



HOIST, WINCHES, and car dumpers with fluctuating loads can be powered with this dc series-wound unit. Allis-Chalmers.

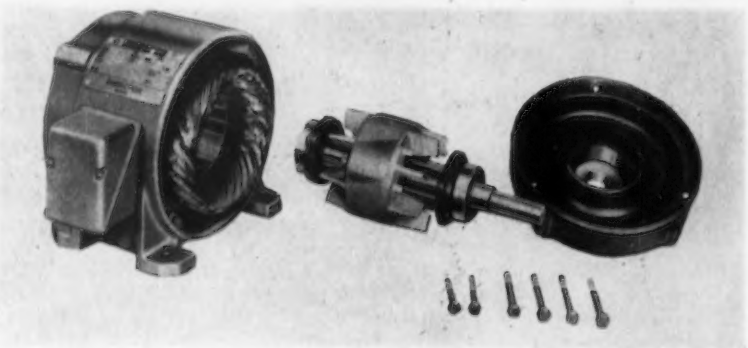


ANNOUNCED JUNE 1, 1957. Open drip-proof model, 40 to 125 hp, has running seals along shaft to keep grease in and dirt out. Bearing gasket prevents oil leakage. General Electric.



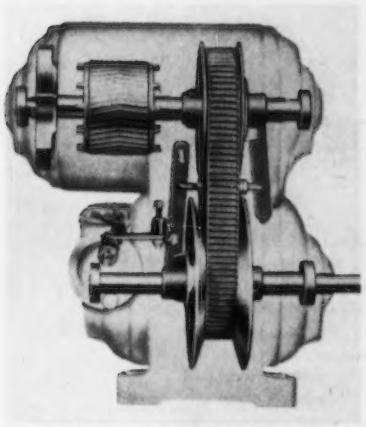
ANNOUNCED JUNE 1 ,1957. First major redesign in 40- to 125-hp ac induction motors by GE in 20 years. Save 20% in weight. More power per frame size. General Electric.

New "Synduction" Electric Motor

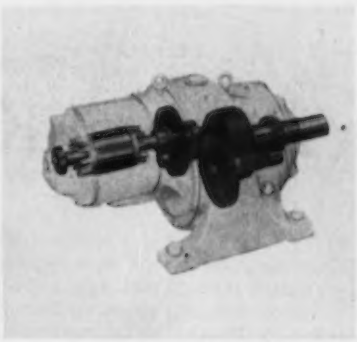


This revolutionary new motor is designed to combine synchronous speeds with simplicity of design of induction motors. It accelerates as a squirrel-cage induction motor until it gets up to speed, and then it operates at synchronous speed without slip from no-load to pull-out. This design makes constant-speed drives dependable, simple and inexpensive. This motor does not require dc excitation. Many industries are now investigating applications of the synduction motor, including the food, textile, packaging, plastic and glass industries. In mining it can be used in proportioning conveyors, positive-displacement type metering pumps and other units requiring accurate speed control.

Synduction motors can be obtained in drip-proof, splash-proof, totally-enclosed and explosion-proof designs. Other special features such as flanges, round frame and conduit-box location can be supplied. Allis-Chalmers.

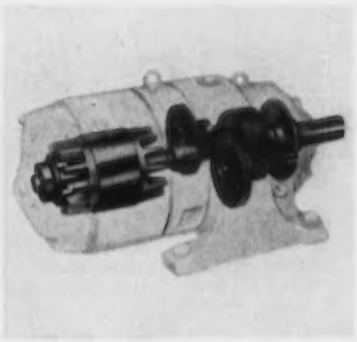


VARIABLE SPEED CONTROL yields high power at slow speed and low power at high speeds. Sizes ½ to 25 hp. Worthington Corp.



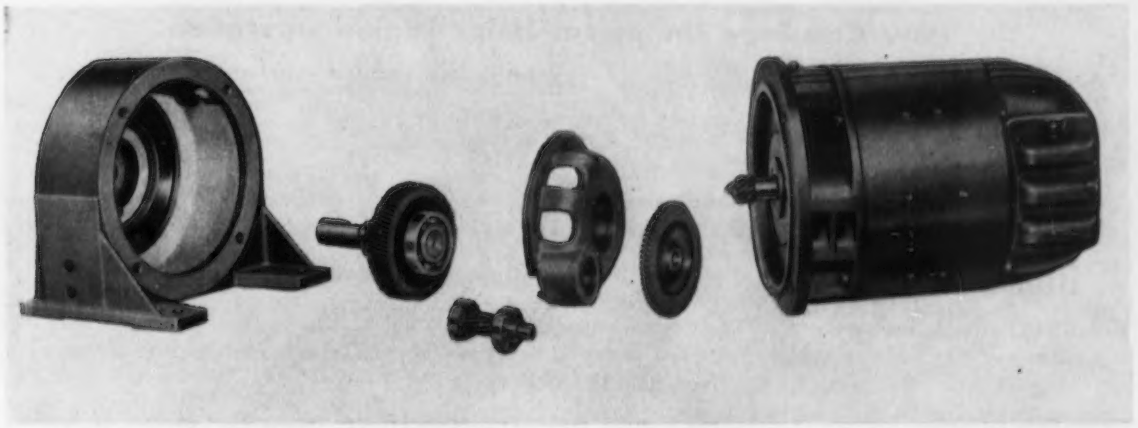
Triple Reduction Motor

ADVANTAGES of "Syncrogear" motor are compactness, safety (no gears exposed), protection of gears against dust and dirt, economy because gear alignment is built-in, and slow speed. Range, 1 to 10,000 rpm. U. S. Electric Motors.



Double Reduction Motor

LOAD IS CARRIED through two pinions of this integral double reduction "Syncrogear" motor. Key to durability of unit is eliptoidal helical tooth design which prevents end failure of gear teeth. U. S. Electric Motors.



SIMPLE CAGE CONSTRUCTION of speed-reduction gearmotor prevents improper gear mating or shaft misalignment. Parts can be interchanged speedily. Entire gear assembly is held by four bolts. Speeds 7.5 to 780 rpm. Reliance Electric.

Service Factors for Typical Electric Motor Drives in the Mining Industry

American Gear Manufacturers list the following service factors which must be applied to horsepower requirements when selecting gearmotor units. Service factors range from 125 to 175% of actual requirements depending upon length of time that units will be operating. Digested from "Westinghouse Speed Reducer Engineering Manual"—Bulletin B-6727.

Application	Hours service per day 8 to 10	24
Agitators		
Pure liquid	1.00	1.25
Liquid and solids	1.25	1.50
Blowers		
Centrifugal	1.00	1.25
Lobe	1.25	1.50
Vane	1.00	1.25
Car dumpers	1.75	....
Car pullers	1.25	....
Compressors		
Centrifugal	1.00	1.25
Lobe	1.25	1.50
Reciprocating, multi-cylinder	1.25	1.50
Reciprocating, single cylinder	1.75	1.75
Conveyors—uniformly loaded		
Apron	1.00	1.25
Assembly	1.00	1.25
Belt	1.00	1.25
Flight	1.00	1.25
Oven	1.00	1.25
Screw	1.00	1.25
Conveyors—heavy duty		
Apron	1.25	1.50
Assembly	1.25	1.50
Belt	1.25	1.50
Bucket	1.25	1.50
Flight	1.25	1.50
Oven	1.25	1.50
Screw	1.25	1.50
Reciprocating	1.75	1.75
Shaker	1.75	1.75
Cranes		
Main hoists	1.00	1.25
Crushers		
Ore	1.75	1.75
Stone	1.75	1.75
Dredges		
Cable reels	1.25	....
Conveyors	1.25	1.50
Cutter head drive	1.75	1.75
Jig drive	1.75	1.75
Maneuvering winch	1.25	1.50
Pumps	1.25	1.50
Screen drive	1.75	1.75
Stackers	1.25	1.50
Utility winches	1.25	....
Elevators		
Bucket (uniform load)	1.00	1.25
Bucket (heavy load)	1.25	1.50
Bucket (continuous)	1.00	1.25
Fans		
Centrifugal	1.00	1.25
Induced draft	1.25	1.50
Large (mine, etc.)	1.25	1.50
Light (small diameter)	1.00	1.25
Feeders		
Apron	1.25	1.50
Belt	1.25	1.50
Screw	1.25	1.50
Disc type	1.00	1.25
Reciprocating	1.75	1.75
Hammer mills	1.75	1.75
Hoists		
Heavy duty	1.75	....
Medium hoist	1.25	....
Skip hoist	1.25	....
Mills, rotary type		
Ball	1.50	1.50
Cement kilns	1.50	1.50
Dryers and coolers	1.50	1.50
Kilns	1.25	1.50
Pebble	1.50	1.50
Rod, plain and wedge bar	1.50	1.50
Tumbling barrels	1.75	1.75
Pumps		
Centrifugal	1.00	1.25
Rotary—gear type	1.00	1.25
Rotary—lobe-vane	1.00	1.25
Proportioning	1.25	1.50
Reciprocating—3 or more cylinders	1.25	1.50
Reciprocating—double acting	....	1.50

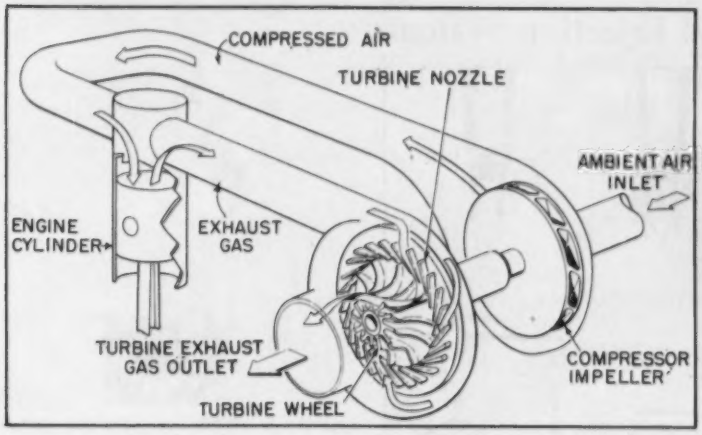
Improvements in Diesel Engine Design

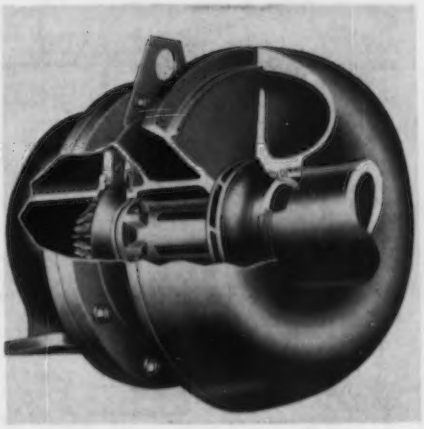
INCREASED POWER OUTPUT, lower operating costs and greater dependability at reduced engine weight per horsepower are the outstanding features of today's diesel engines used to power trucks, tractors and other earth-moving equipment. These features are the result of engine manufacturers developing a number of novel accessory engine units, of which the turbocharger and improved fuel injection system are the most important, and the result of making use of better materials and precision machining techniques. The line of engines to choose from today makes possible correct matching of engine and application. In the table below will be found the major accessory units applied and how they affect engine performance.

How Accessory Equipment Helps Engine Operation

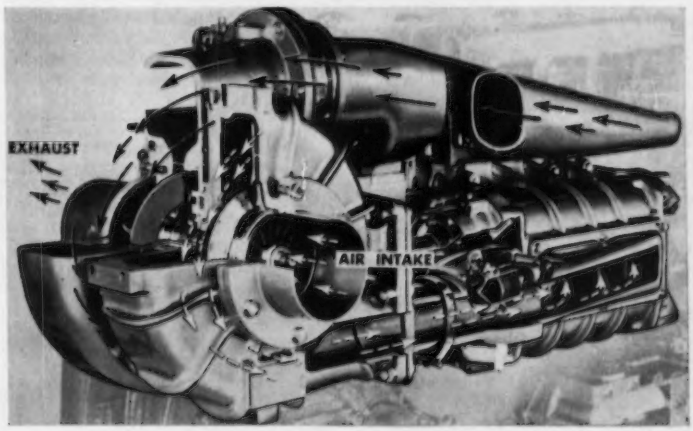
Accessory engine equipment	What it does to improve operation
Turbocharger	Can increase engine hp up to 50% plus
Fuel injection systems	
Capsule type Unit injector type PT type IH type	Makes possible use of power-rich, low-cost fuels. Metered injection. Positive and complete combustion
Full-flow, by-pass cooling system	Thermostat controlled it gives a quick warm up, uniform engine temperatures and increased flow through radiator, assuring adequate cooling even in high ambient temperatures
Cross-flow radiator	Controls water flow to maintain 170-deg temperature in spite of weather conditions
Heat exchanger	This type of cooling system is not affected by ambient air temperatures, air circulation or contaminated air. Adequate raw water supply essential
Water pump	Provides an adequate flow of cooling water every minute from radiator under all operating conditions
Jet cooling pistons	Removes excess heat, thus reducing ring temperatures and preventing carbon build-up and ring sticking
Air cleaner	Protects engine from abrasive action of dust and grit. Longer engine life
Fuel filter	Filters out microscopically small particles from fuel, thereby protecting entire fuel injection system
Oil filter	Treats all oil each time it circulates through engine. Assures good lubrication for hundreds of hours
Oil cooler	Maintains lubricating qualities of oil. Fewer oil changes, less down time for engine
Starter (air-gasoline engine-electric-hydraulic)	Makes possible quick and all-weather starting of engine
Engine balancer	Makes possible smooth engine performance and longer life

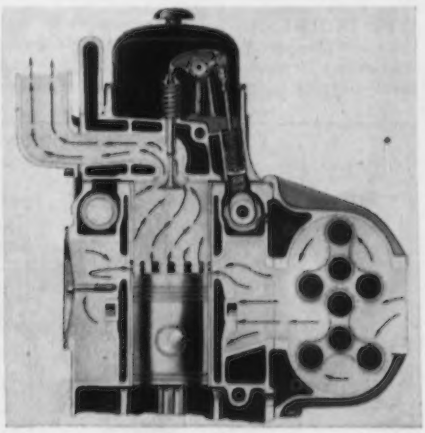
Turbocharging Systems



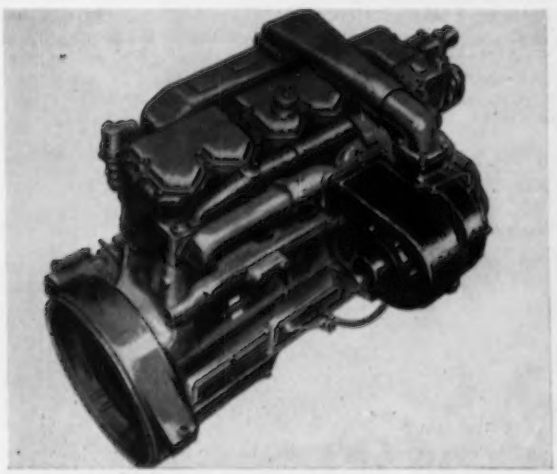


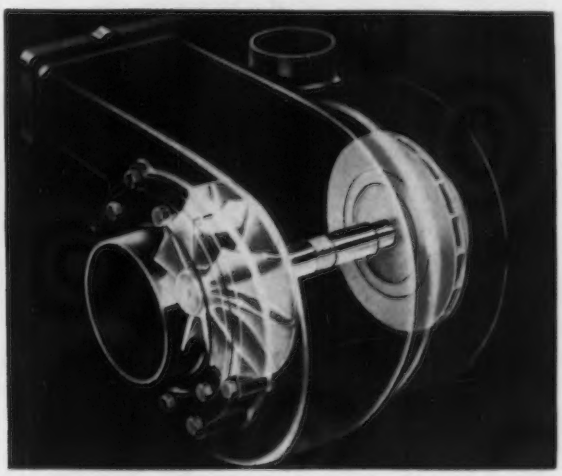
THIS SCHEMATIC drawing shows how the turbocharging system on Caterpillar diesel works. The turbocharger proper at right with its gas turbine driven by the exhaust gases of engine and centrifugal air compressor packs more air into each cylinder of the engine, thereby making it possible to take additional large amounts of power from the engine.





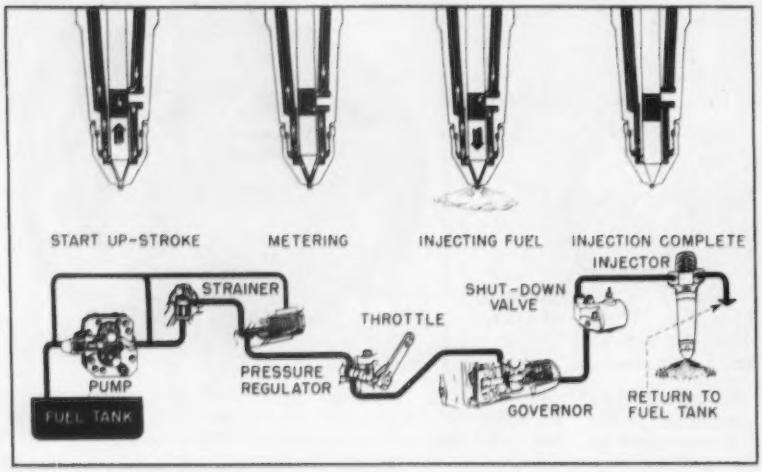
NOVEL TURBOCHARGING SYSTEM shown serves a two-cycle, Model 6130T Detroit Diesel engine. Black arrows (at left) show how exhaust gases turn a single-stage turbine wheel which drives a single-stage air impeller. The fast rotating impeller boosts the intake air pressure and permits the slower turning Roots-type blower at right, operating under less load, to provide more air for combustion and scavenging in the engine. White arrows indicate air flow.



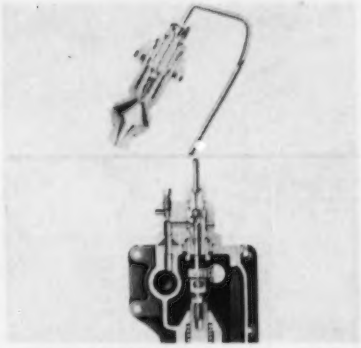


INSTALLATION of the newly designed turbocharger on Cummins NRTO-6 diesel engine, 743-cu. in., has increased power output to 335 hp at 2,100 rpm, or 67½% over the natural aspirated engine of same cubic inch displacement.

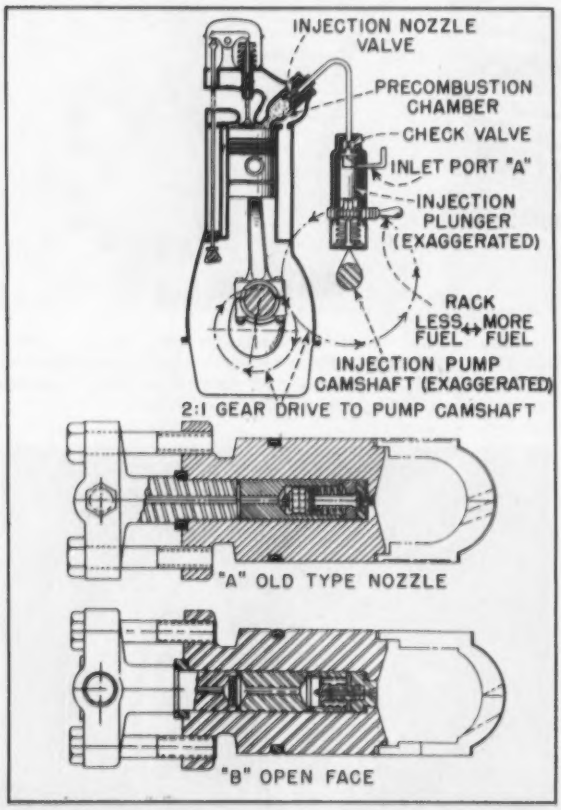
Fuel Injection Systems



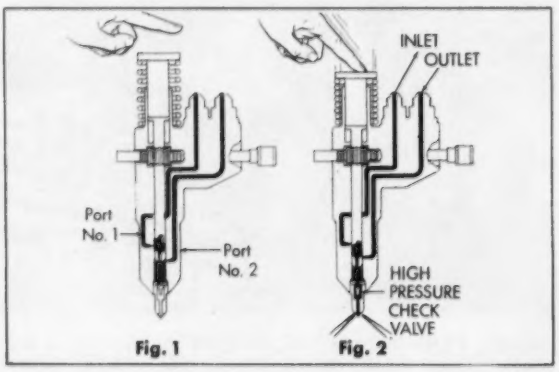
THE PT (PRESSURE-TIME) principle of fuel metering utilizes a fixed size opening in a simple 7-part injector and variable pressure to meter the fuel charge into the cylinders. Pressure at metering opening is controlled by throttle, and time interval while opening is uncovered is determined by crankshaft and engine speed (*Cummins*).



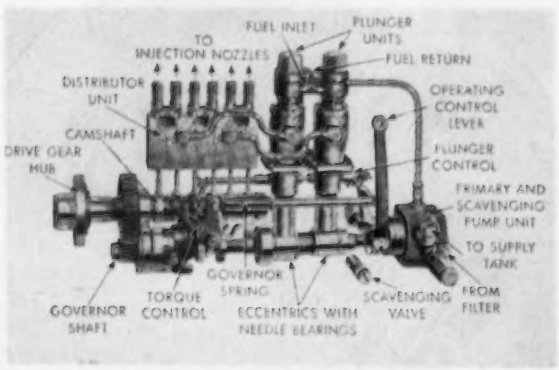
CAPSULE TYPE fuel injection valves and injection pump are the outstanding features of Caterpillar fuel injection system. Injection valve in center of nozzle is a small capsule that permits easy, inexpensive replacement. Large, single orifice combined with precombustion chamber affords fault-free operation on a wide range of fuels, including No. 2 burner oil.



IH FUEL injection system. New "open face" nozzle used eliminates skipping at high and low idle speeds and prevents coking, thus increasing valve life. Fuel is partially burned in precombustion chamber and then blown with spiral motion through large opening into main combustion space. Resultant thorough mixing of fuel with air assures positive, complete combustion (*International Harvester*).



IN THE UNIT INJECTOR fuel system high pressure lines are eliminated because high pressure is applied at the injector tip. In Fig. 1, plunger is all the way up, while in Fig. 2, it is in a downward position where fuel is compressed and injection is completed (*Detroit Diesel*).



SKELETON VIEW of a twin-plunger injection pump shows how each plunger distributes fuel to three cylinders. Primary fuel pump and fuel return scavenging pump at right (*International Harvester*).

Water and Oil Cooling Systems

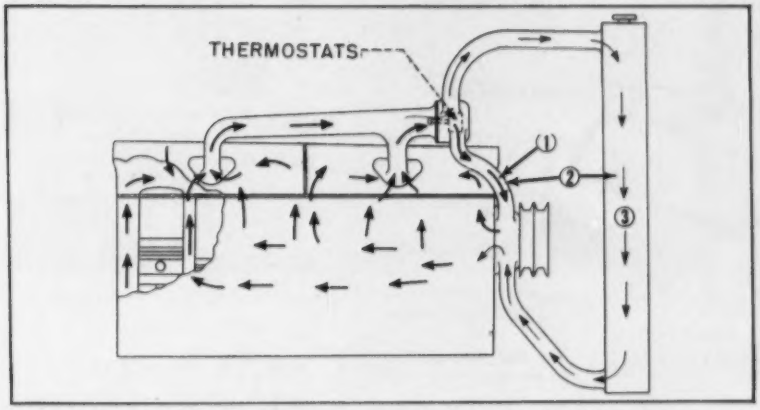


FIG. 1 shows layout and thermostat control of a new full flow by-pass water cooling system. Water flow during engine warm-up period, up to 155 deg F, is indicated by heavy arrows. Between 155 and 185 deg, water flows through both the by-pass system and radiator. When engine is at full operating temperature (185 deg) water flows through radiator only as shown by light arrows (*International Harvester*).

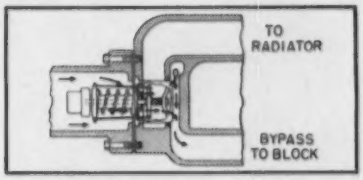


FIG. 2. Position of Detroit thermostat used in system during warm-up period. Outlet to radiator is completely shut off.

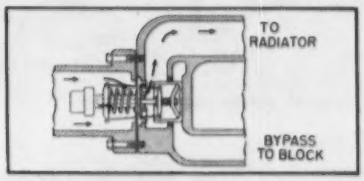
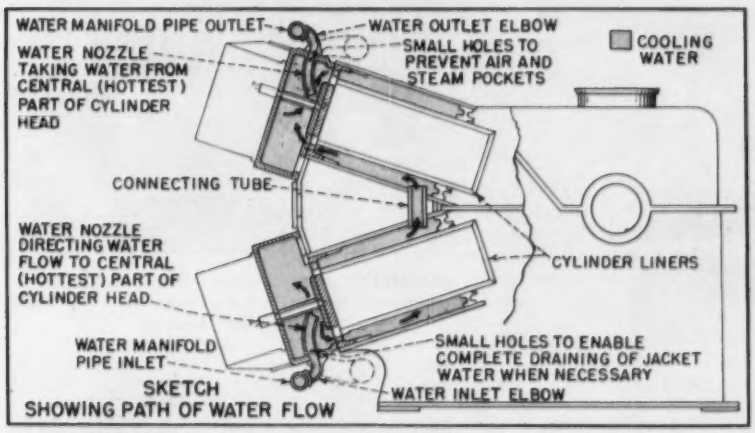
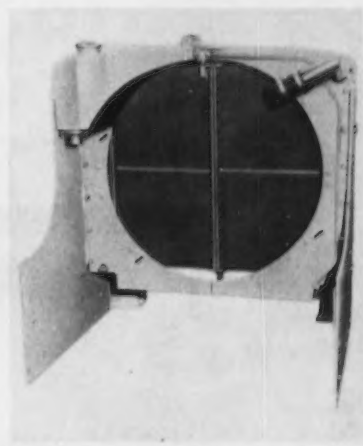


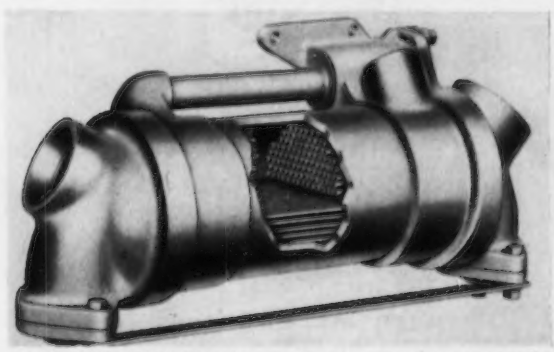
FIG. 3 shows Detroit thermostat in main-flow position. The radiator outlet is open and by-pass outlet closed.


WATER MANIFOLD PIPE OUTLET
WATER OUTLET ELBOW
SMALL HOLES TO PREVENT AIR AND STEAM POCKETS
COOLING WATER
WATER NOZZLE TAKING WATER FROM CENTRAL (HOTTEST) PART OF CYLINDER HEAD
CONNECTING TUBE
WATER NOZZLE DIRECTING WATER FLOW TO CENTRAL (HOTTEST) PART OF CYLINDER HEAD
CYLINDER LINERS
WATER MANIFOLD PIPE INLET
SMALL HOLES TO ENABLE COMPLETE DRAINING OF JACKET WATER WHEN NECESSARY
WATER INLET ELBOW
SKETCH SHOWING PATH OF WATER FLOW

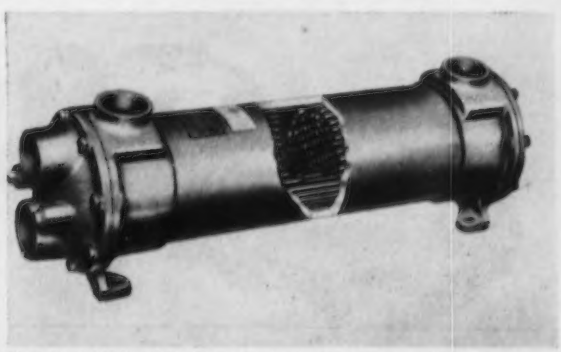
WATER COOLING system designed for Page Horizontal-V diesel engines used on draglines. High temperature areas around injectors are cooled by pipes directing flow of water on to injector nozzles in lower bank, creating turbulence above injectors on upper bank. Small holes in pipes bleed upper bank of air when cooling system is filled and allow water to drain from lowest point when engine is drained. All manifolds run along outside of the V for easy access to cam shaft housing.



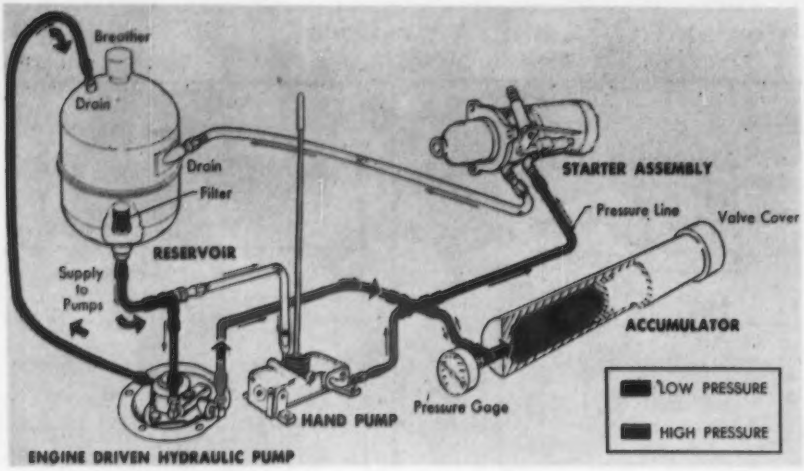
CROSS-FLOW RADIATOR is designed to make use of maximum cooling area. Regulators control water flow to maintain an even 170-deg temperature in spite of weather conditions (*Caterpillar*).



LUBE OIL COOLER. The large amount of water passing through the cooler every minute maintains an oil temperature below 200 deg F (*Caterpillar*).

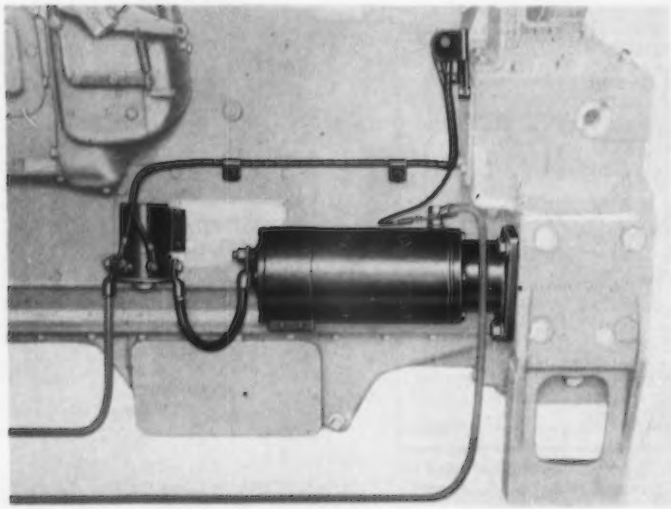


HEAT EXCHANGER. Installed on engine where adequate raw water is available. This cooling system is not affected by air temperature, circulation or contamination (*Caterpillar*).

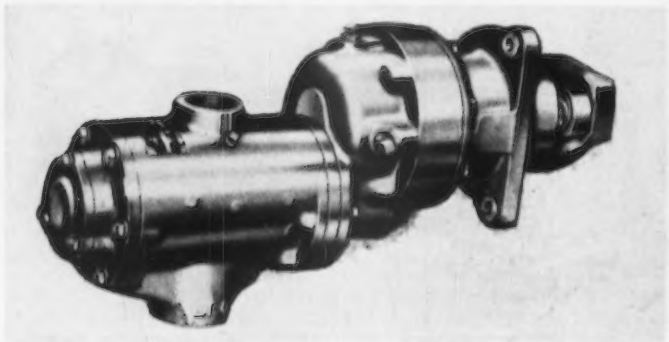


THIS IS HOW the new GM Hydrostarter system operates. Complete installation weighs about 100 lb. Instant start under most adverse weather conditions possible.

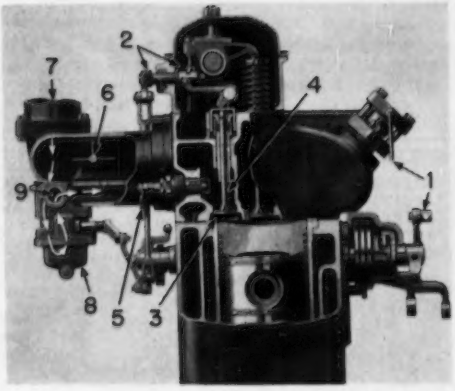
Engine Starter Systems



DIRECT ELECTRIC 24v starting system. Newer units include ether starting aids in conjunction with glow plugs to inject ether into air intake manifold of engine, making possible starts at low temperatures.

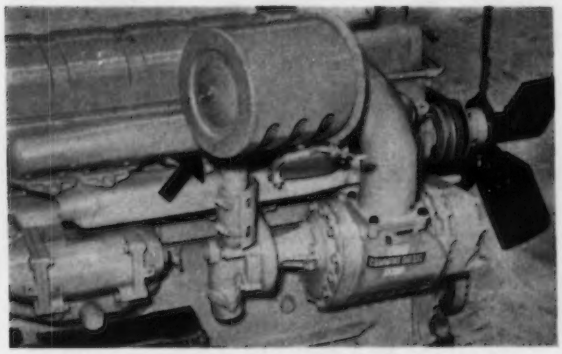


COMPRESSED AIR starter. Where compressed air is not readily available, starting system includes a vane-type air motor bolted to flywheel housing.

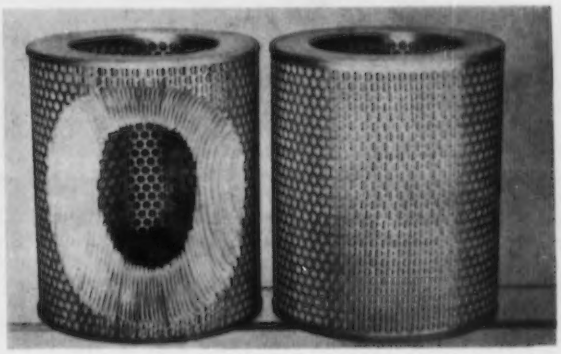


GASOLINE starting engine. System preconditions engine and supplies lubrication before it is started. All-weather starting.

WILCO START PILOT provides quick starting of engine. Unit injects a small quantity of ignition starting fluid of low ether content mixed with air into engine intake manifold. Starts at temperatures minus 60 deg F are possible.

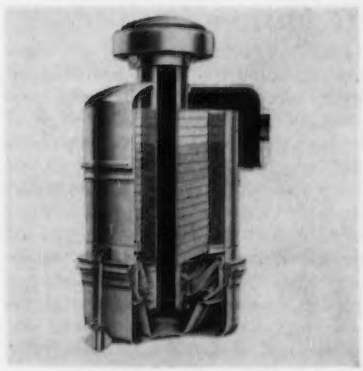


PUROLATOR'S fabric filter resembles well known oil line filter.



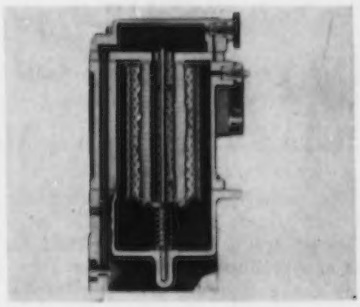
FABRIC air cleaners are standard on *Cummins Diesel* engines.

Filters—Engine Balancers—Jet Piston Cooling—Water Pumps

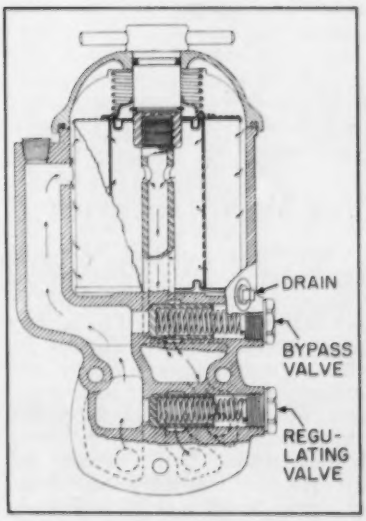


CUTAWAY view of *Caterpillar* air cleaner assembly for diesels.

LARGE CAPACITY water pumps of this type with self-adjusting seals provide an adequate flow of water every minute from radiator under all operating conditions. Belt or gear driven. (*Caterpillar*)

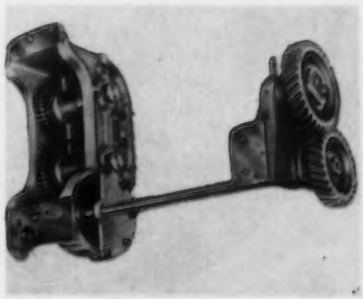


THIS OIL FILTER assembly using impregnated paper filter elements protects engine parts and fuel injection system on *Caterpillar* diesels.

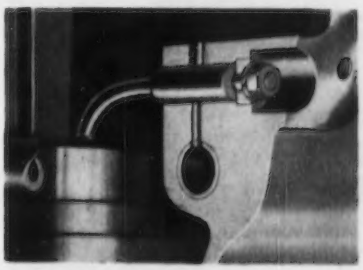


IH FULL FLOW oil filter unit with safety bypass valve. When filters are plugged valve opens, allowing oil to go direct to oil passages (*International Harvester*).

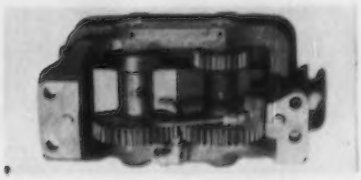
Addresses of the manufacturers of diesel engines and accessories may be found in the Manufacturers' Directory of the Buyers' Guide in this issue.



CATERPILLAR'S balancer with two gear-driven offset weights gives 4-cylinder diesel engines all the smoothness of 6-cylinder performance.



CARBON BUILDUP is reduced and ring sticking cut by cooling piston assemblies by oil spray jet just below cylinder liners (*Caterpillar*).



LANCHESTER BALANCER in center of crankcase eliminates unbalance of 4-cylinder *International Harvester* diesel engines. The two eccentric weights are gear driven in opposite directions.

New Units That Promise Better Mechanical Power Transmission

POWER TRANSMISSION equipment is classified in the Buyers' Guide section of this Guidebook. Companies offering various mechanical power transmission units are listed under the items which appear in the classified section. Here are the important headings which appear in the equipment guide section of this issue:

Bearings, Ball
Bearings, Needle
Bearings, Plain Non-Metallic
Bearings, Plain, Oil Impregnated and Sintered Metal
Bearings, Roller
Bearings, Sleeve
Bearings, Thrust
Bearing Metal
Bearing Pillow Blocks, Hangers and Journal Boxes
Belts, Flat Power Transmission
Belts, "V"
Blocks, Pulleys and Sheaves
Brakes, Dynamic
Brakes, Friction, Disk and Block
Brakes, Magnetic
Chain, Power Transmission
Clutches, Friction
Couplings, Fluid
Couplings, Rigid
Drives, Belt
Drives, Chain
Drives, Fluid
Drives, Gear
Drives, Gear, Shaft-Mounted
Drives, Magnetic and Eddy Current
Drives, Variable
Gears and Pinions, Metal
Gears and Pinions, Metal, Large Ball Mill, Mine Shaft etc.
Hubs, Auto Wheel, Selective Drive
Power Take-Offs
Torque Converters
Transmissions

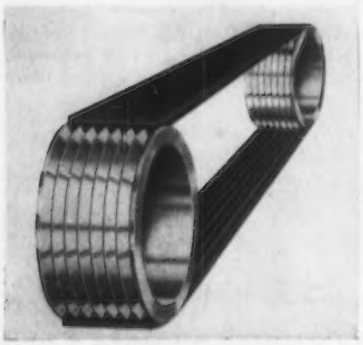
Do You Want to Cut Mining Costs?

Here's a Suggested Mechanical Program.

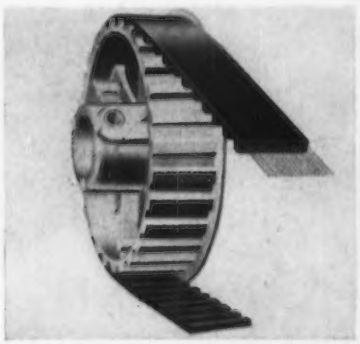
In preparing this section and the Buyers' Guide elsewhere in this issue, the editors have reviewed hundreds of new products releases received during the past year, numerous manufacturers' bulletins, power transmission handbooks, and all of the literature available at recent mining equipment shows at Denver, Los Angeles and Cleveland. It's impossible to present a complete digest of all the useful new ideas contained in this mass of source material. However you can compile your own company power-transmission library easily. Simply set up a classification system. The one presented above will do for a starter. Then write to the manufacturers listed under power transmission items in the Buyers' Guide section. You will be amazed at the volume of practical information they have to offer.

The handbook sections of some of the catalogs on V-belts, chain drives, and other devices should be at the elbow of every plant design engineer. Many manufacturers offer manuals which tell you how to select, install and maintain power transmission equipment. Such a simple item as a V-belt drive must be selected and installed with meticulous care, or you will ruin not only the belt and drive but the motor shaft and driven machine as well.

After you have compiled your up-to-date power transmission library, check your plant and notice the hundreds of machines including pumps, flotation machines, compressors, fans, hoists, conveyors, elevators, classifiers etc. in which the power source, such as an electric motor, is linked to the working machine with some type of power transmission unit such as a flexible coupling, V-belt, fluid or magnetic clutch, gear-reduction set or possibly even a torque-converter. Check new and improved types of power transmission equipment available to see whether you are losing a good percentage of energy through inefficient or completely out-dated devices. One catalog, for instance, publishes a chart which shows that the efficiency of a worm gear reduction unit can drop to 60% or less when the ratio of reduction approaches 100:1. With losses of this magnitude, mine operators can afford to spend considerable time selecting not only the best available speed reduction unit, but also the best available motor with speed output suitable for the machine to be driven. (See section on electric motors p 124.)



NEW POLY-V BELT eliminates matching problems, increases belt and sheave life, transmits more power in same drive space. Raybestos-Manhattan.

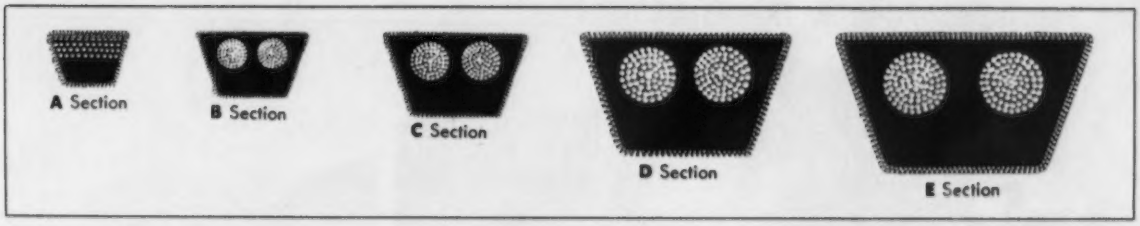


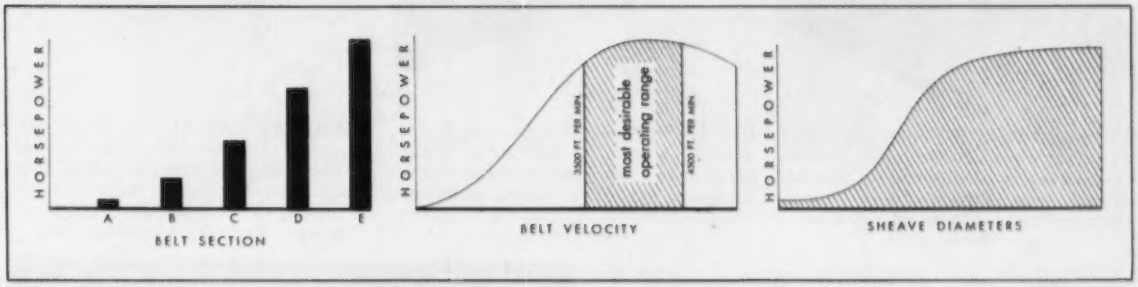
POSITIVE-GRIP rubber timing belt meshes with cogged drive pulleys. Good for fans, pumps, compressors and blowers. United States Rubber Co.

For Mine Libraries

Twenty-five companies making V-belts have contributed to a useful manual, "Engineering Standards, Multiple V-belt Drives," which should be in every mine library. Standards covered include, V-belt sheaves, V-belts and multiple V-belt drives. Copies available for $1 from Multiple V-Belt Drive & Mechanical Power Transmission Assoc., 27 E. Monroe St., Chicago 3, Ill., or the Rubber Manufacturers Assoc., 444 Madison Ave., New York 22, N. Y.

Engineering tables in the manual tell how to calculate horsepower rating for various belt sections used in mining equipment.





Basic Engineering Principles to Aid in Selecting V-Belt Drives

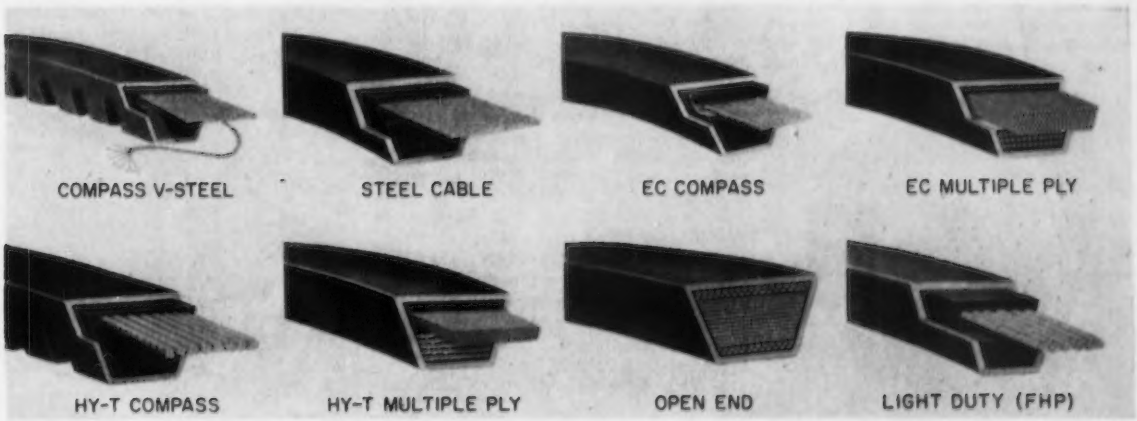
V-belts are designated in sections as shown above. Sections are actual size and all belt manufacturers use the same designated letters. Construction of belt will of course vary. Sections shown above are Allis-Chalmers "Texrope" high-capacity belts.

Belt section. Selection of a V-belt drive for any application should be based on the type of load, shaft speeds, type of driver and its rated horsepower.

Belt speeds. The belt speed, or belt velocity, is important in figuring load capacity. Note optimum operating range above.

Sheave diameters. Larger diameter sheaves enable belts to transmit greater loads through increased belt speeds and because of less severe belt flexing. Smaller diameter sheaves result in more grooves, and seldom make up the most economical drive.

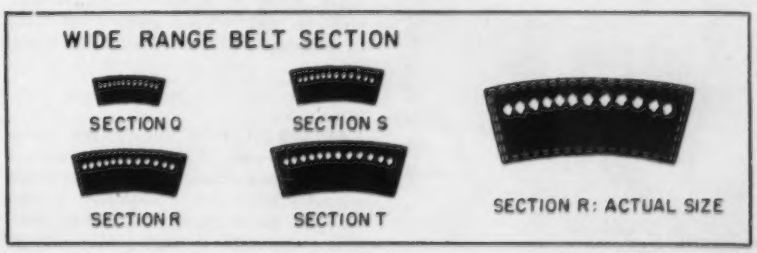
Foregoing basic principles appear in Tex-Book 20P40—a manual on Texrope Drives published by Allis-Chalmers, Milwaukee 1, Wis.

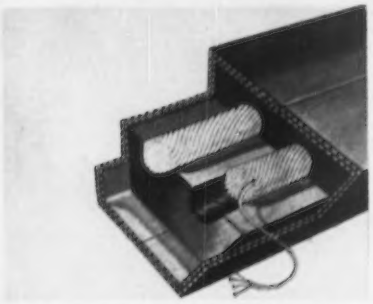


V-BELT CONSTRUCTION. Compass V-Steel belt has very high strength. Steel Cable V-belt is designed for longer lengths and heavier drives. HY-T Compass gives excellent performance on short-center high-speed drives. HY-T Multiple type is used for longer heavier drives. EC Compass is for short center, small sheave fast drives. EC Multiple Ply is for large, normal-speed drives where heavy shock loads may be encountered. Open-end belts are for line-shaft drives and no-take-up drives. Light Duty (FHP) belts are for pumps and light machinery, refrigerators, and stokers. Worthington-Goodyear V-Belts.

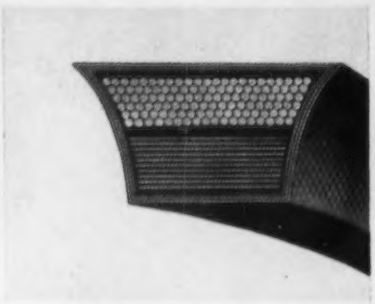
Wide Range V-Belts

The belts shown at right are wider than the conventional A, B, C, D and E section belts. They are used with variable-pitch drives and effect a wider range of speed. S and T-section belts are used in large size speed changers. All types are oil proof. Allis-Chalmers Texrope.

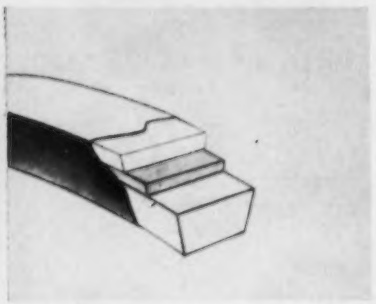




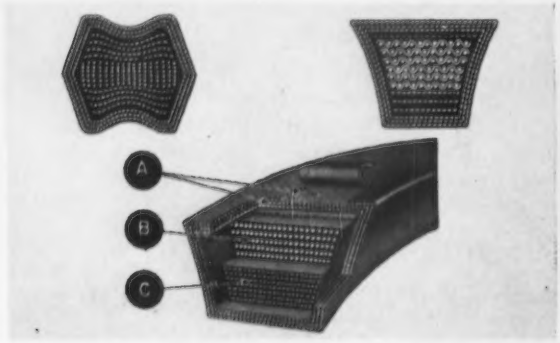
CORD-REINFORCED V-belt is designed to increase drive capacity by as much as 40%. Cover is oil resistant to prolong life of belt. Reinforcing cords are set in tensile section of belt to prevent stretching. Thermoid Co.



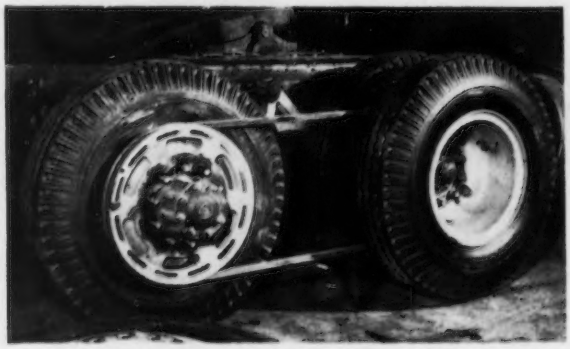
HIGH-STRENGTH tensile cords in top section of belt provide 40% greater horsepower capacity. Concave sides straighten out under operating tension and provide uniform contact with sheave groove. Gates Rubber Co.



FOUR FUNCTIONAL parts of a V-belt consist of: 1. Cover which must protect other sections. 2. Extensions section (top) which flexes over sheave. 3. Neutral axis in center. 4. Compression section at bottom. Raybestos-Manhattan Inc.



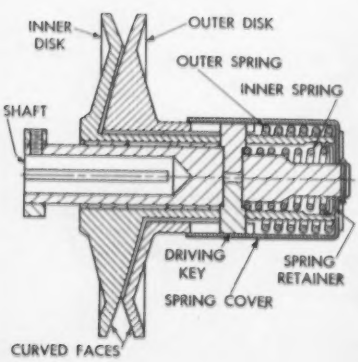
SPECIAL BELTS. Sealed belt bottom includes abrasion resistant cover (A), reinforced tensile section (B), and load cushion section (C). Double-V is for load-reversal jobs. Other belt can be cut to length for fasteners. Dodge Mfg. Co.



NEW TANDEMATIC DRIVE consists of powerful V-belt encircling sheaves mounted between each of two rubber tires on duel-tire rear wheels of truck. Should be ideal for hauls on poor mine roads. Gates Rubber Co.

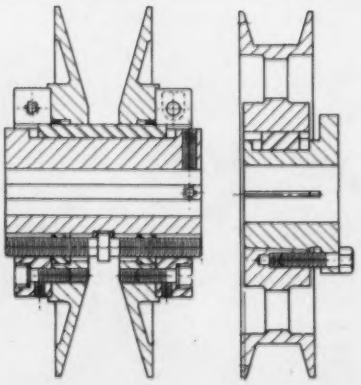
◄ **TWO-GROOVE** adjustable sheave affords speed variation up to 50%. Pitch diameter is changed by turning moveable disc to desired position and locking it firmly with a set screw. Allis-Chalmers.

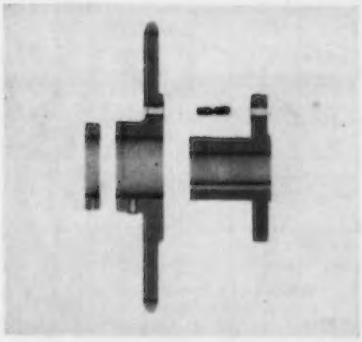
WORM-GEAR ADJUSTMENT MECHANISM is provided on this multi-groove V-belt drive pulley for applications where precise speed and positive adjustment must be maintained. This mechanism comes as an accessory for standard variable-pitch drive pulleys. Allis-Chalmers. ►



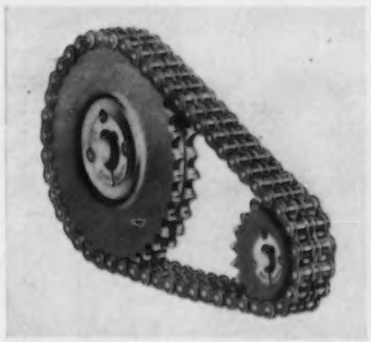
◄ **VARIABLE-SPEED** motor pulley is designed to use "A" belt sections. Disk separation widens as unit is shifted to the right on the motor drive shaft. Pulleys are made of semi-steel. They come in ratios up to 2.75:1. Worthington Corp.

VARIABLE-PITCH sheave for wide-range "R" and "W" V-belts. Movement of flanges is controlled by large hardened adjusting screw just beneath hub. Sheave adjacent to it is a companion fixed wide-range type. Browning Mfg. Co. ►

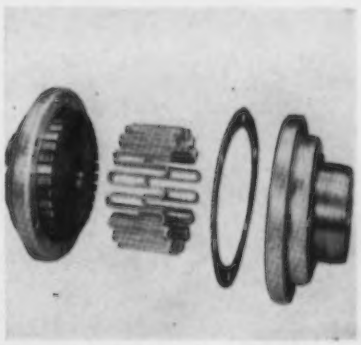




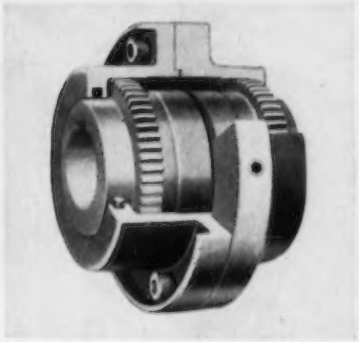
SHEAR PIN which joins hub with roller chain sprocket protects chain drive against shock loads. Link-Bolt Co.



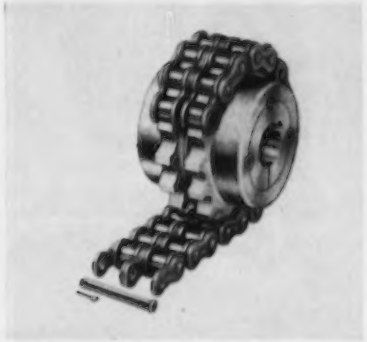
TAPER-LOCK sprocket simplifies mounting unit on shaft. No reboring, keseating or drilling required. Dodge Mfg. Corp.



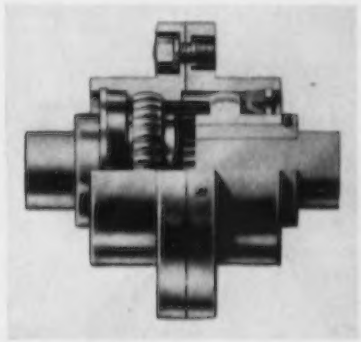
FLEXIBLE-STEEL spacer coupling is used where gap is needed between motor and machine shafts. Falk Corp.



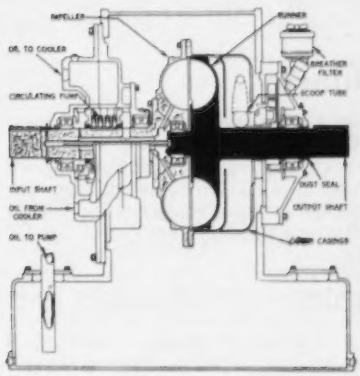
GEARED flexible coupling transmits high load and compensates for minor shaft misalignment. Link-Belt Co.



CHAIN COUPLING features "taper-lock" attachment, accomodates slight shaft misalignment. Dodge Mfg. Co.

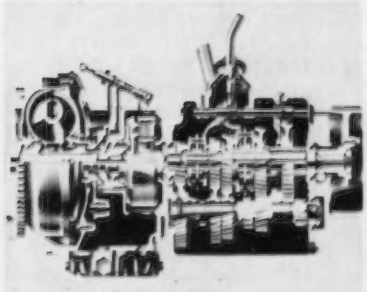


CURVED TEETH on gears permit increased deflection between mating members, Philadelphia Gear Works.



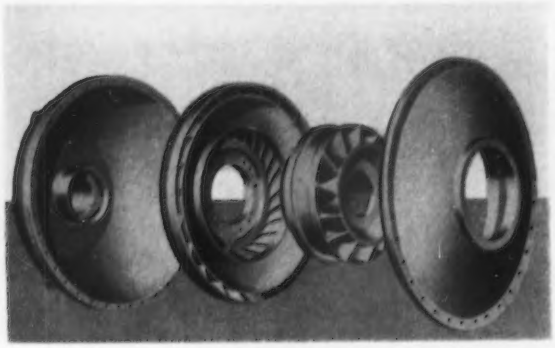
◄**FLUID DRIVE** transmits power from drive shaft at left to equipment shaft at right. Vortex of oil in circular section meshes the impeller and runner. Available in ½- to 12,000-hp sizes. Good for rotary-drill drive and metallurgical processing machinery. American Blower Corp.

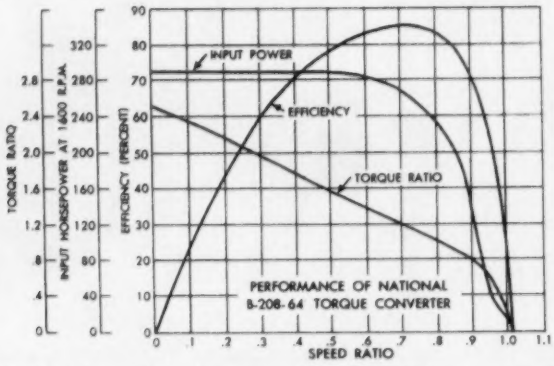
FLEXIDYNE dry fluid drive contains "fluid" of heat-treated shot. As drive housing gains speed, shot is forced to outside and meshes firmly with vane connected to driven rotor shaft at right. Unit can be attached to V-belt drive for motor, direct shaft-to-shaft installation or flexible coupling. Dodge Mfg. Corp. ►



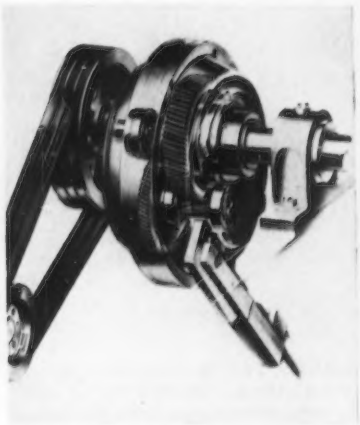
◄ **TRANSVERTER** consists of a torque converter, hydraulic disconnect clutch and standard transmission in one complete unit. Maximum torque multiplication is 2.75:1. Designed for off-highway and stop-and-go conditions for haulage trucks and construction equipment. Clark Equipment Co.

NEW THREE-STAGE torque converter is built for every horsepower range from 40 to 1,000 hp. Unit is designed for applications previously unserved such as industrial locomotives and oil field equipment. Models available for engines made by Allis-Chalmers, Caterpillar, Climax, LeRoi and others. Twin Disc Co. ►

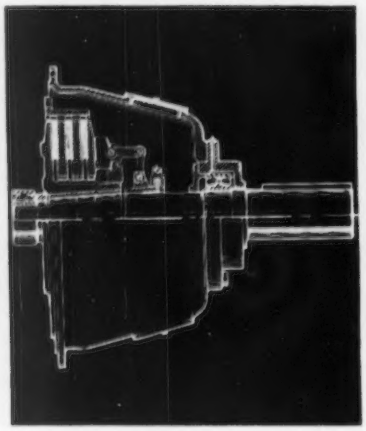




SINGLE-STAGE torque converter comes in sizes 100 to 1,000 hp. Within capacity range, converters are handling changing loads and speed requirements easily. Note efficiency curve at right for varying speed and torque ratios. National Supply Co.



COMPACT speed reduction drive for screw conveyors or V-belt drives available in ½ to 10 hp. American Pulley Co.



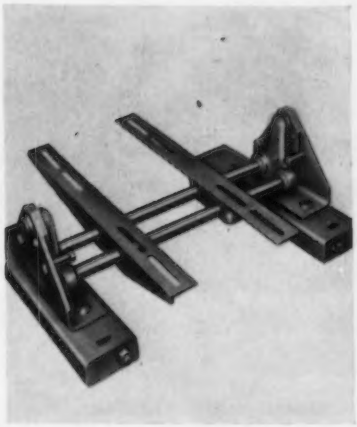
POWER TAKE-OFF for high-speed, high-horsepower industrial engines. Units have 1, 2 or 3 disks. Twin-Disc Co.

SHAFT-MOUNTED gear reduction drive for screw conveyors, belt conveyors, feeders and other mine units. Falk Corp.

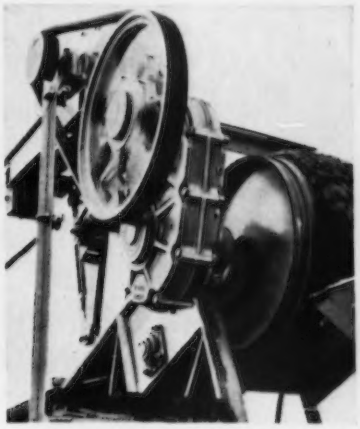
Table of Load Characteristics for Mining Machinery

Load characteristics are classified below as U for uniform load, M for moderate shock, and H for heavy shock. When selecting power transmission units such as gears and gear-reduction units, V-belts and V-belt pulleys and motors for mine equipment be sure to consult correction-factor tables published by most manufacturers before selecting equipment. If the prime mover is an electric motor running 24 hr per day, actual horsepower requirements must be increased by the following percentages to allow for service factor for speed reducers: Uniform load, add 25%; moderate shock load, 50%; and heavy shock load 75%. Table below showing applications from Gearmotor Bulletin GM-560 by philadelphia Gear Works, Inc.

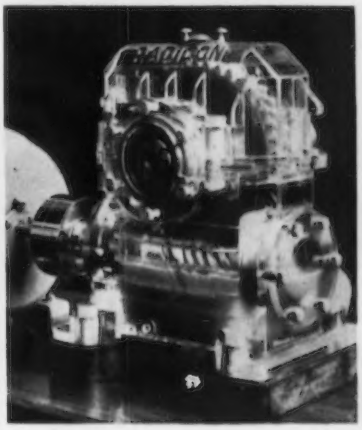
Application	Type of Load
Agitators	
Pure liquids	U
Liquids & solids	M
Liquids, variable density	M
Blowers	
Centrifugal	U
Lobe	M
Vane	U
Car dumpers	H
Car pullers	M
Clarifiers	U
Classifiers	M
Compressors	
Centrifugal	U
Reciprocating, multi-cylinder	M
Reciprocating, single-cylinder	H
Conveyors—Uniformly Loaded or fed	
Apron	U
Assembly	U
Belt	U
Bucket	U
Chain	U
Flight	U
Oven	U
Screw	U
Conveyors—heavy duty	
Apron	M
Belt	M
Bucket	M
Chain	M
Flight	M
Oven	M
Reciprocating	H
Screw	M
Shaker	H
Cranes	
Main hoists	U
Bridge travel	U
Trolley travel	U
Crusher	
Ore	H
Stone	H
Dredges	
Cable reels	M
Conveyors	M
Cutter head drives	H
Jig drives	H
Maneuvering winches	M
Pumps	M
Screen drive	H
Stackers	M
Utility winches	M
Elevators	
Bucket—uniform load	U
Bucket—heavy load	M
Bucket—cont.	U
Fans	
Centrifugal	U
Induced draft	M
Large (mine, etc.)	M
Light (small diameter)	U
Feeders	
Apron	M
Belt	M
Disk	U
Reciprocating	H
Screw	M
Hammer Mills	H
Hoists	
Heavy duty	H
Medium duty	M
Skip hoist	M
Mills, rotary type	
Ball	M
Cement kilns	M
Dryers & coolers	M
Kilns	M
Pebble	M
Rod, plain & wedge bar	M
Pullers	
Barge haul	H
Pumps	
Centrifugal	U
Proportioning	M
Reciprocating	M
Rotary	U



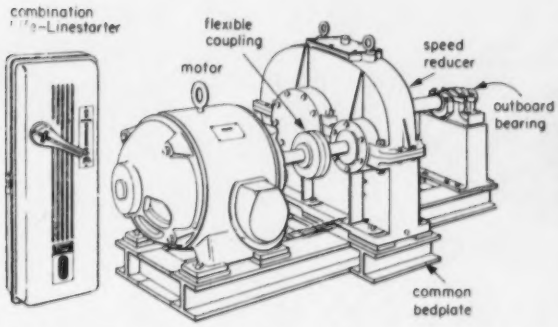
NEW MOTOR TILTING BASE automatically matches belt tension to varying motor loads. American Pulley Co.



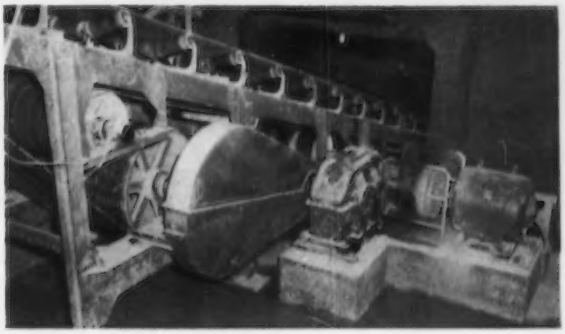
TORQUE-ARM speed reducer mounted on belt head pulley transmits 60 hp at speed of 100 rpm. Dodge Mfg. Co.



WORM-GEAR speed reducer will take overloads of 100% for 15 sec, 25% overloads for 2 hr. Radicon.



COMPLETE DRIVE includes bedplates, outboard bearings, backstops, flexible couplings, motor and control equipment. This, with speed reduction unit makes up complete package. Westinghouse Electric.

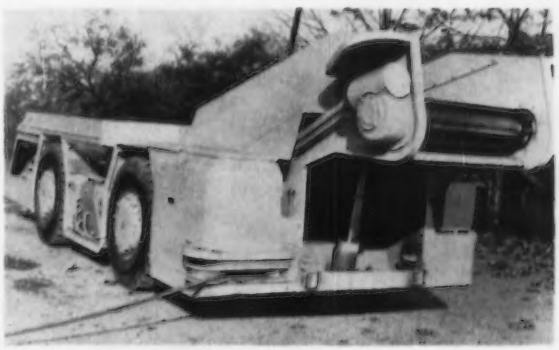


POWER TRANSMISSION sequence at modern Barvue mill includes motor, fluid drive (in screen), coupling, gear reducer and multiple V-belt drive connected to mid-flight conveyor-belt drive pulley.

Summing It Up

The foregoing highlights of mechanical power transmission equipment represent only a portion of the units which come under this heading. It is *E&MJ*'s suggestion that you round out your mine library of useful cost-cutting information by contacting manufacturers of mechanical power transmission equipment for the wealth of handbooks, engineering data books and manuals which we have had the privilege of studying in presenting this limited review. See Buyers' Guide and Manufacturers' Directory at end of this Guidebook for names of units and addresses of makers.

Just to convince yourself that more attention should be given to power transmission units by mine operators consider the new shuttle car at right as an example. In common with all other mine equipment and plant installations, this machine contains hundreds of shafts, couplings, gears, pinions, bearings, chains, sprockets, etc. Each item constitutes a link between the kilowatt-hours of energy that you buy and the job you want done. If each of these links is inexpertly chosen—or if each does not represent the latest in efficient design, the cumulative effect will be high power costs per unit of work done, and low output per man running the machine.



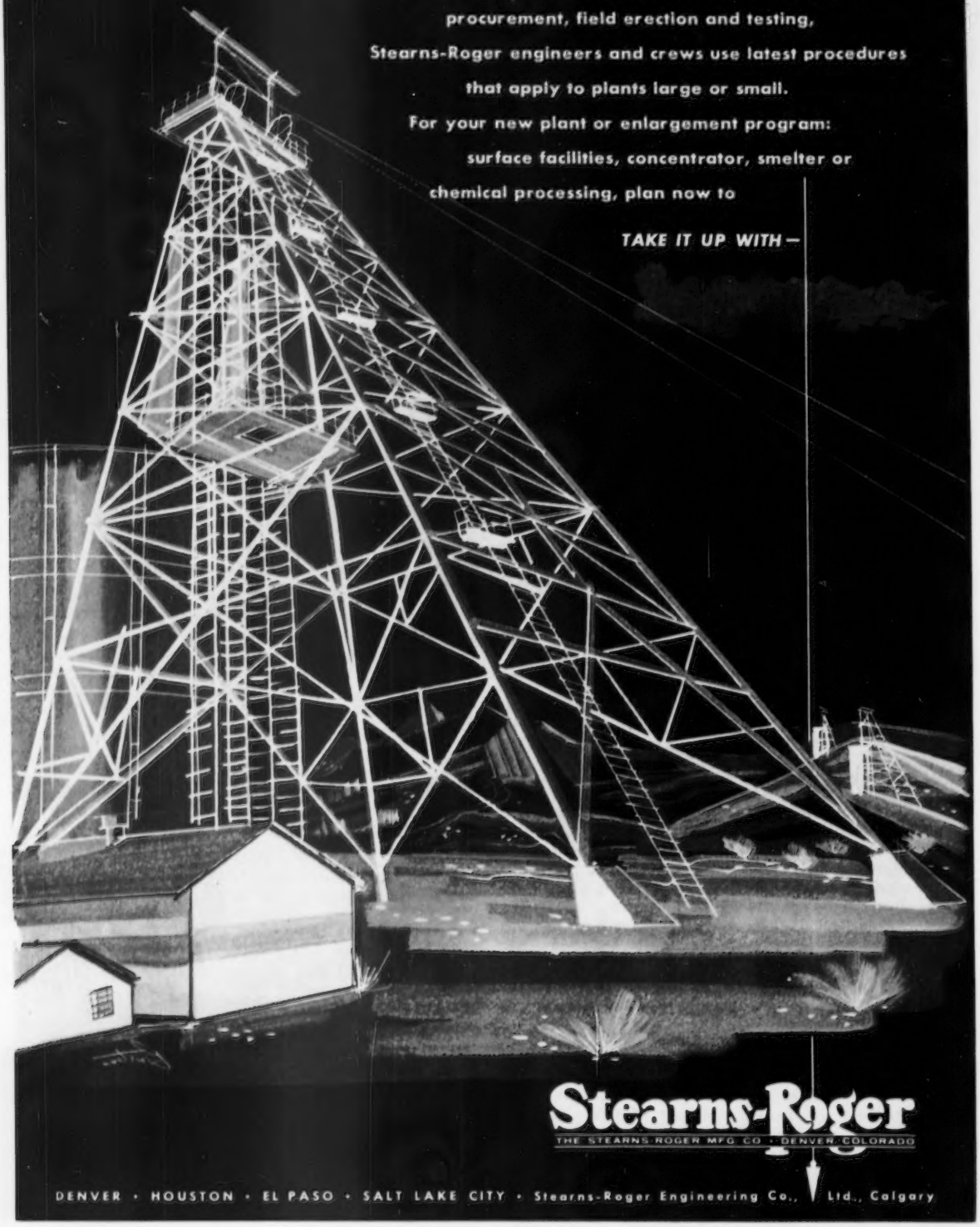
NEW SHUTTLE CAR operates traction drive, steering, boom, and conveyor with single ac or dc motor. National Mine Service.

This new shuttle car offers two other object lessons: (1) It contains a torque converter which smooths out load pick-up. (2) It comes in ac or dc models. Thus high dc feeder-line losses can be discounted. Note also unusual application of fluid drive on conveyor drive at the Barvue mill (above). Barvue also uses fluid drives on its ball mills.

through ALL stages . . .

At each step: design, engineering, fabrication,
procurement, field erection and testing,
Stearns-Roger engineers and crews use latest procedures
that apply to plants large or small.
For your new plant or enlargement program:
surface facilities, concentrator, smelter or
chemical processing, plan now to

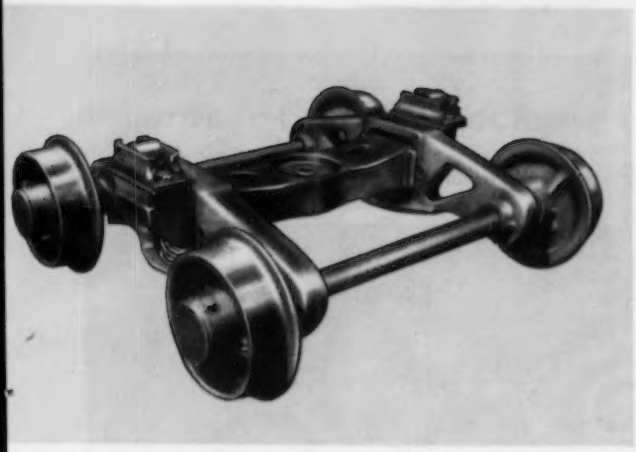
TAKE IT UP WITH—



Stearns-Roger

THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO

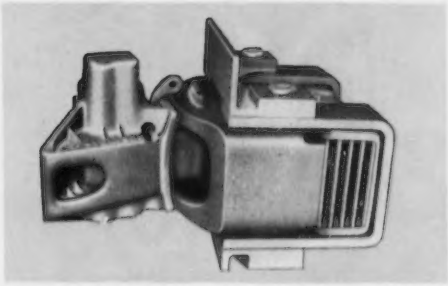
DENVER • HOUSTON • EL PASO • SALT LAKE CITY • Stearns-Roger Engineering Co., Ltd., Calgary



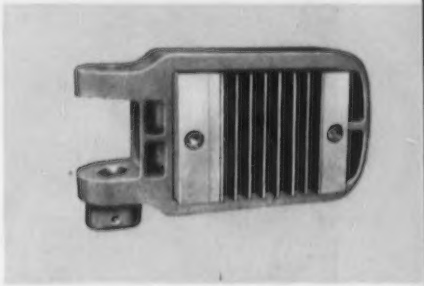
NATIONAL equipment cuts per-ton costs

NC-1 MINE CAR TRUCK is the latest example of National's pioneering in better equipment. Among NC-1 truck advantages are longer and softer ride springs, friction damping mechanism that controls vertical and transverse oscillations, automatic frame alignment and cast one-piece bolster with large lubricated center bearing. A 9121

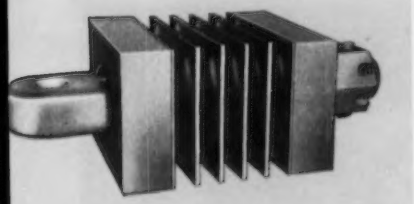
WILLISON AUTOMATIC COUPLERS save time with maximum safety, couple at either end of car or locomotive, require no manual assistance, eliminate damaging slack, permit high speeds with maximum stability.



NATIONAL MI-235 Rubber-Cushioned Draft Gear primarily used in Willison spherical-horn coupler assemblies for drop-bottom cars and locomotives; are effective with link and pin bumpers and in strap yokes.

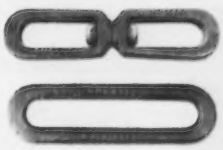


NATIONAL MI-225 Rubber-Cushioned Draft Gear for locomotives and large capacity cars not required to operate through rotary dump. Give maximum impact protection in minimum space.



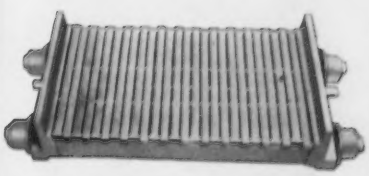
NATIONAL MI-230 Rubber-Cushioned Draft Gear for cars in rotary dump service. High-capacity rubber pads with soft initial action provide maximum impact protection, lengthen equipment life. Available in capacities and designs to fit individual requirements.

NACO STEEL WHEELS, made from quality-controlled Naco cast steel—of high yield point, great tensile strength and ductility—reduce tread spalling or flange breaking. Available in all sizes regularly used in mining or industrial operations.



NACO STEEL SWIVEL HITCHING AND LINK

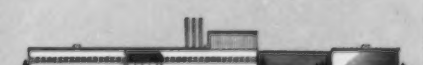
CAST ALLOY STEEL ORE-GRINDING BALLS



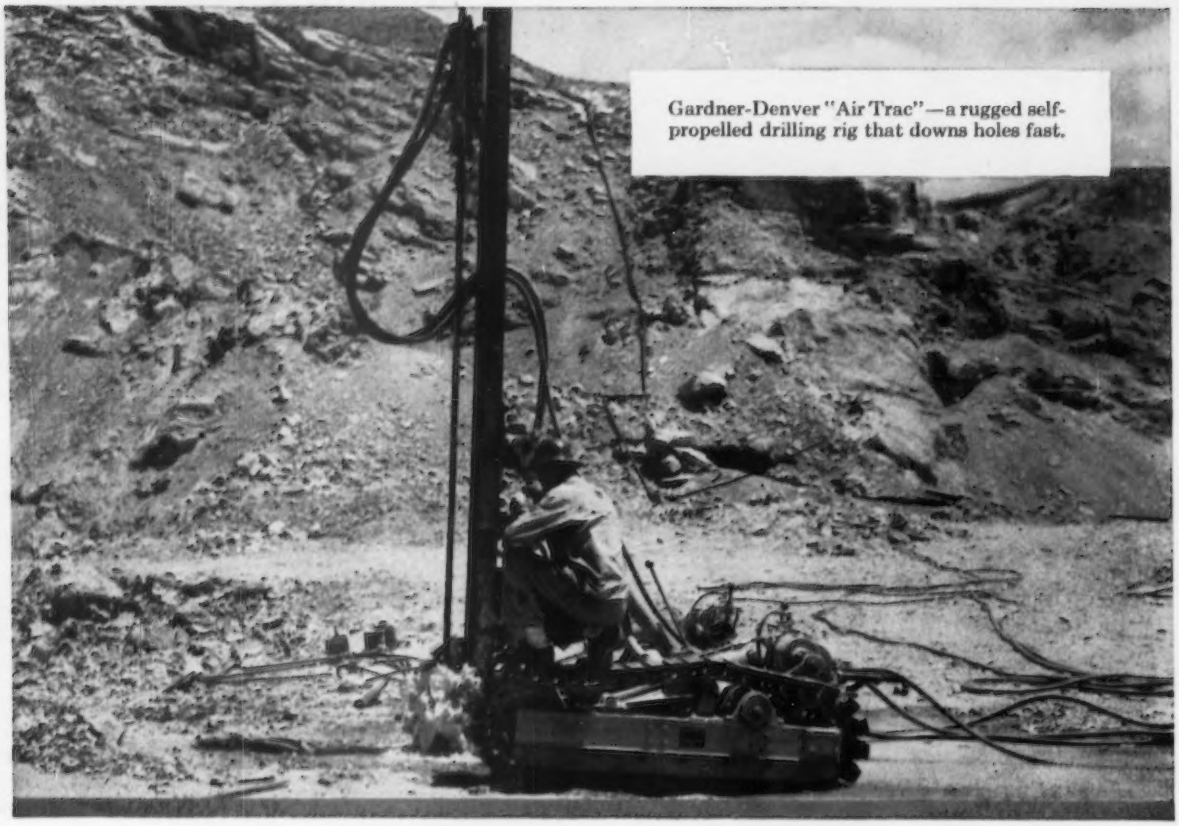
CAST STEEL PALLET AND MALLIX SINTERING BARS

NATIONAL MALLEABLE AND STEEL CASTINGS COMPANY • Cleveland 6, Ohio

Technical Center

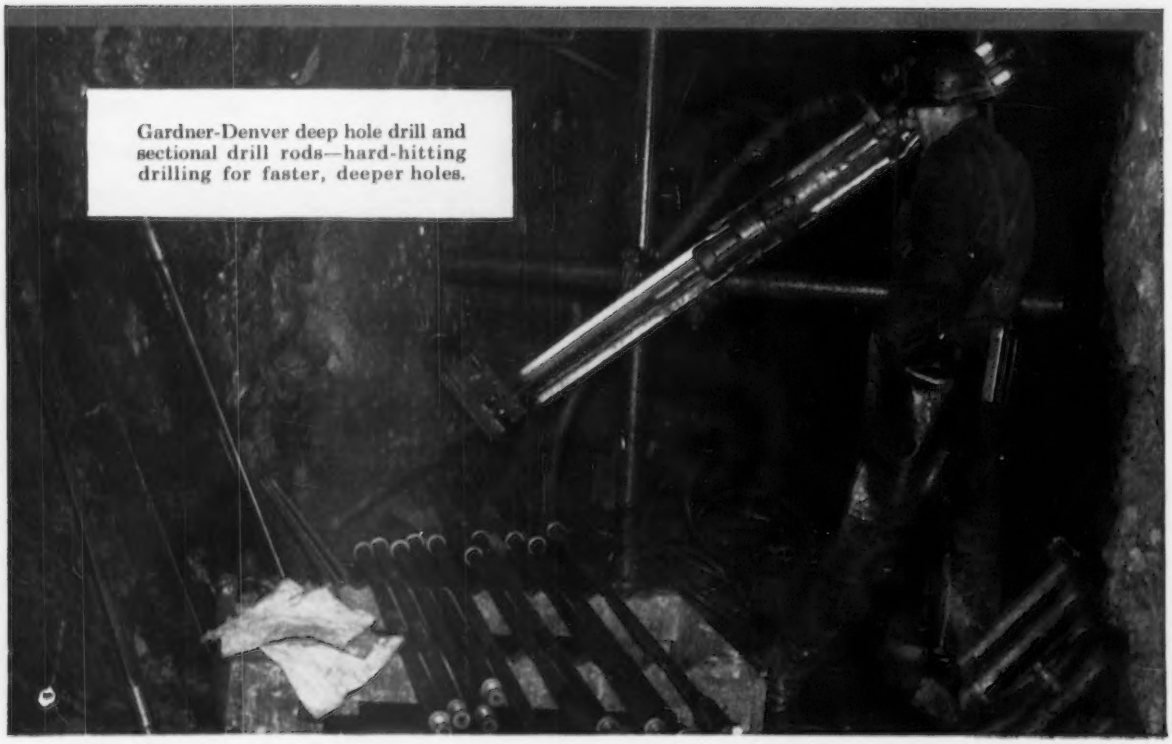


"Progress through Research"



Gardner-Denver "Air Trac"—a rugged self-propelled drilling rig that downs holes fast.

ABOVE GROUND . . . OR DOWN BELOW . . .



Gardner-Denver deep hole drill and sectional drill rods—hard-hitting drilling for faster, deeper holes.

A Gardner-Denver check list of fast, safe mining equipment

- ☐ "MOBILJUMBO"®
- ☐ Super 5 ½" DH143 Drill
- ☐ Deluxe "Air Trac"®
- ☐ "Air Trac"
- ☐ Wagon Drills
  LACM WD URM
- ☐ Deep Hole Drills
  DH99 DH123 DH143
  SFH99 SFH123
- ☐ Ring Seal Shanks, Sectional Drill Rods
- ☐ Sinkers
  S33 S48 S55 S58 S73
- ☐ Breakers
  B37 B67 B87
- ☐ Tampers
  TT23 T23 T43 TT43
- ☐ Air Tools
- ☐ Hydraulic Drill Jumbos
  J1H J2H J3H
  J1P J2P J3P
- ☐ Automatic Stopers
  RB104 RB94 R68
- ☐ Chain Feed Drifters
  CF73 CF79 CF93 CF99
- ☐ Screw Feed Drifters
  SF73 SF79 SF93 SF99
- ☐ Air Leg Drills
  FL48 FL58
- ☐ Air Feed Legs
  FL2B FL3B
- ☐ Air Motors
- ☐ Air Hoists
  HK HB HM HE
- ☐ "Airslushers"®
  HEE HKE HME
- ☐ Shaft Muckers
  HKL HMK HML HMS
- ☐ Mine Car Loaders
  GD9 GD10 GD14
- ☐ Sump Pumps
  VP4 VP8

GARDNER-DENVER HELPS SPEED PRODUCTION

- ☐ Hydraulic Drill Support
  JA Series Booms
  DPU Drill Positioner
  JTB Tripod Boom
- ☐ Columns
  Single Screw Double Screw
  Pneumatic
- ☐ Drill Steel Forges
- ☐ Bit Grinders
- ☐ Line Oilers
  L07 L08 L09
  L011 L012 L014
- ☐ Dewatering Pumps
- ☐ Grout Pumps
- ☐ High-Pressure Pumps
- ☐ Centrifugal Pumps
- ☐ Rotary Portable Compressors
  RP600 RP900
  RP125 RP365
- ☐ Stationary Compressors
  WB HA RX AA AC

See your Gardner-Denver mining equipment specialist or write for bulletins.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER-DENVER

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Gardner-Denver Export Division, 233 Broadway, New York 7, New York
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Airborne magnetometer survey plane over gold mines area near Johannesburg

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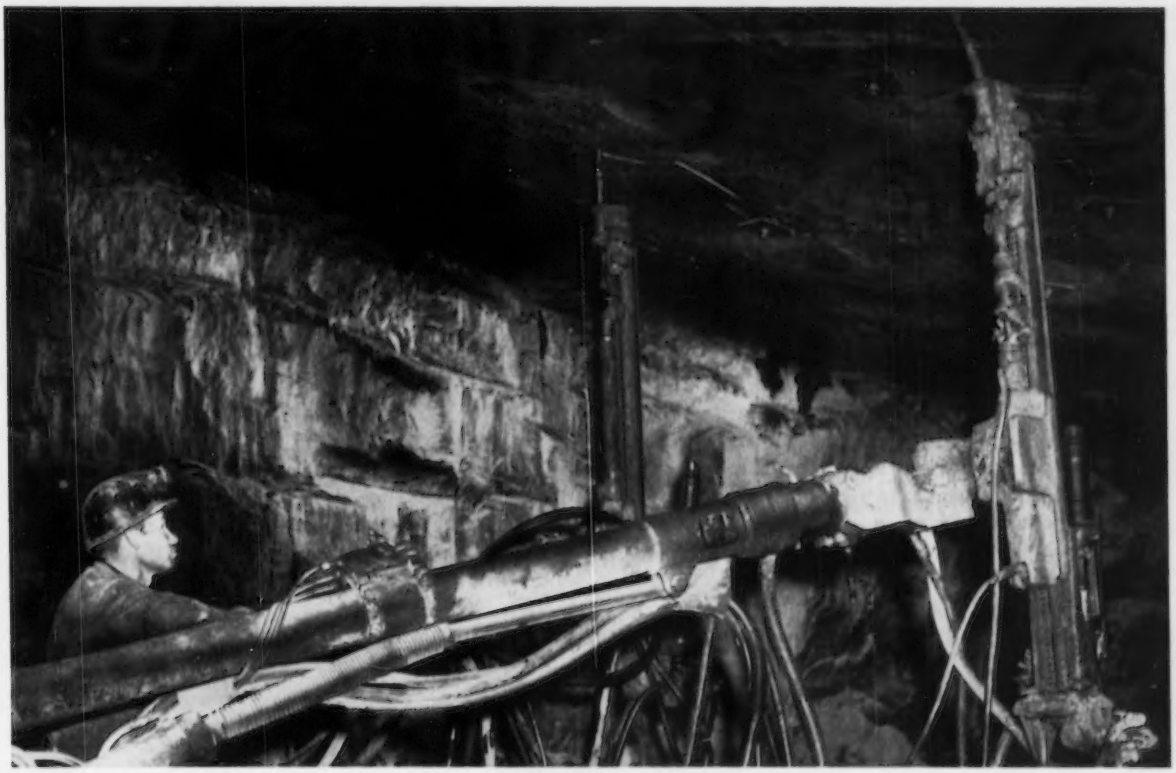
ENGINEER'S FIELD REPORT

LUBRICANT CHEVRON* VISTAC OIL

LOCATION A COAL MINE IN UTAH

Chevron* Vistac Oil protects mine roof bolters operating in water and heavy abrasive dust



WORKING CONSTANTLY in heavy abrasive dust, high humidity and water in one of Utah's largest coal mines, these Joy roof bolters are lubricated with Chevron* Vistac Oil. To eliminate crossbar timbering and provide greater safety and increased production, these air tools drill holes, hammer bolts and tighten nuts on steel bearing plates. Bolts up to 8 feet long are rammed in to refusal at pressures up to 3,000 lbs. psi.

The master mechanic for underground operations at the mine reports: "Vistac Oil has proved completely satisfactory for this tough service. It continues to lubricate and protect these machines even under our most difficult dust and water conditions." Chevron Vistac Oil is also used in all other air equipment in the mine.

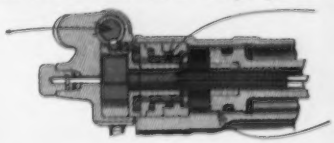
For More Information about this or other petroleum products of any kind, or the name of your distributor, write or call any of the companies listed below.

* The Chevron Brand covers the line of industrial products formerly sold under the Calol name. This is a name change only. The high quality and specifications remain the same.

CHEVRON Industrial Lubricants

TRADEMARKS "CHEVRON," "VISTAC" AND DESIGN REG. U.S. PAT. OFF.

Why Chevron* Vistac Oil cuts costs in air-tool equipment



- Atomizes quickly and completely—carries evenly over all parts. Prevents excessive fogging and has no unpleasant odor.
- Additives help form tenacious, oily, pressure-resistant film in wet or dry conditions—cuts wear and power loss. Small quantity lubricates efficiently.
- Resists high temperatures and oxidation. Stays fluid at low temperatures.

STANDARD OIL COMPANY OF CALIFORNIA, 225 Bush Street • San Francisco 20, California

THE CALIFORNIA COMPANY, P. O. Box 780 • Denver 1, Colorado

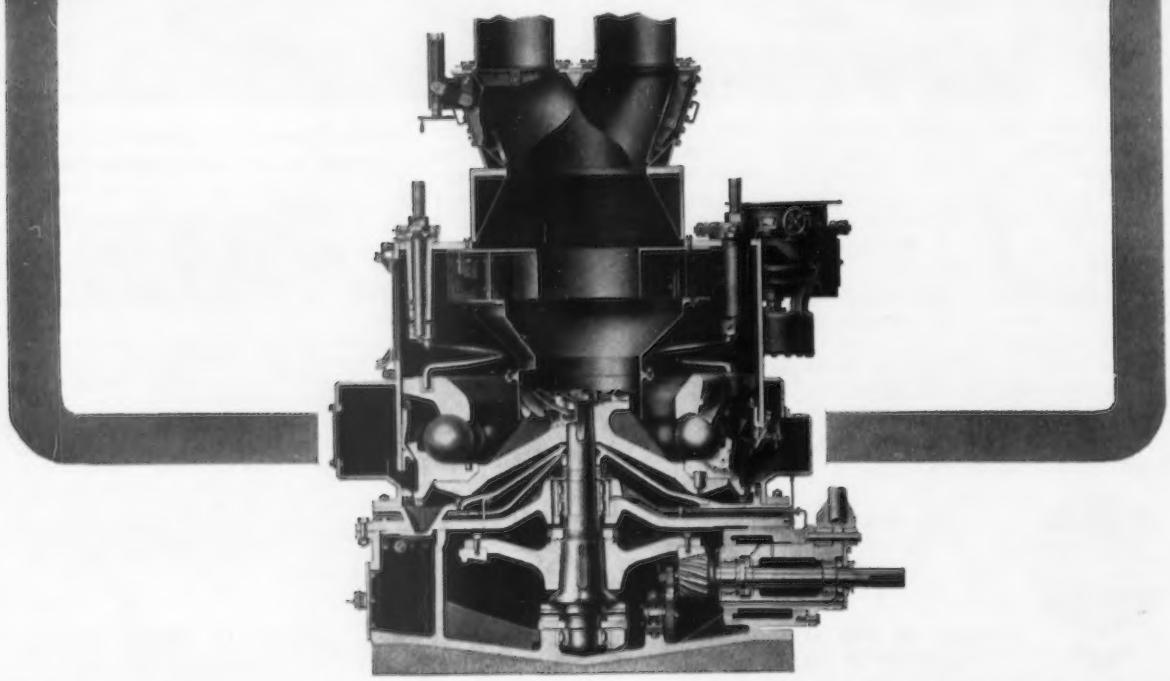
STANDARD OIL COMPANY OF TEXAS P. O. Box 862 • El Paso, Texas

B&W Fuel-Handling, Fuel-Burning are Cutting Processing Costs in Metallurgical Plants

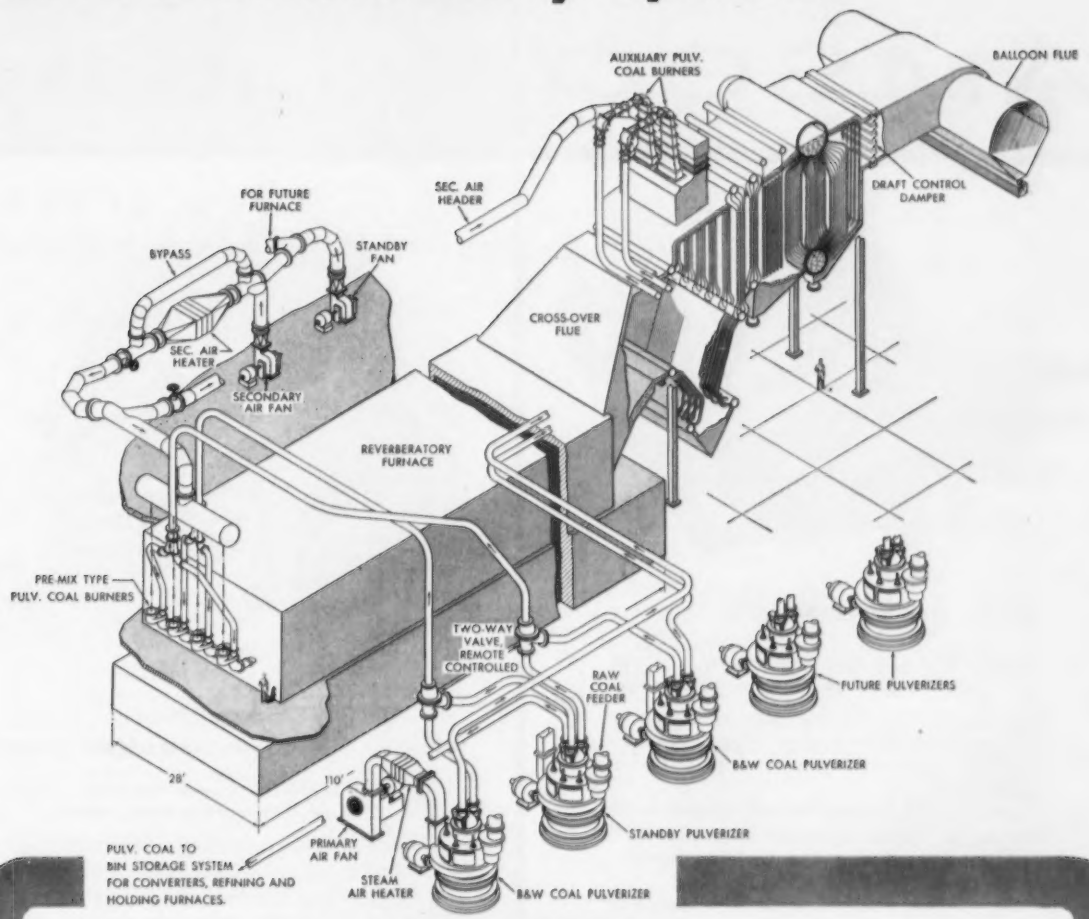
PULVERIZED-COAL FIRING

B&W Direct-Firing and Circulating Pulverized-Coal systems are serving industrial furnaces of various capacities. Although these furnaces are often located in separate areas throughout a plant, the coal supply to each can be independently controlled from a central pulverizing system.

The solution of unusual problems common to firing industrial furnaces with pulverized coal is one of a number of plus values that can promote higher production, lower operating cost, and reduction of furnace maintenance. For plant expansion, modernization of metallurgical fuel-fired furnaces, and waste-heat recuperation, B&W offers broad research, engineering and production experience.



and Heat-Recovery Systems



HEAT RECOVERY

The reverberatory furnace, waste heat boiler, and pulverized coal firing equipment shown above are a part of a fully integrated mine, mill, and smelter, started up in 1955 to produce 75,000,000 lb of fire-refined copper annually from low grade chalcocite ore.

The firing equipment is arranged with ample standby capacity to provide uninterrupted operation of the reverberatory furnace. During regular maintenance shutdowns on the furnace, continuous steam generation can be maintained by firing the boiler with the auxiliary coal burners.

Modern boiler design permits uninterrupted furnace operation with a single boiler, eliminating the problems of a two-boiler arrangement with its costly cross-over flue design and refractory maintenance.

Heavily dust-laden, high-temperature, corrosive gases from the reverberatory furnace are easily handled in this streamlined, single-pass boiler under natural draft.

Low draft loss, elimination of external corrosion and effective cleaning are accomplished with remote automatic steam soot blowers. *The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York, 17, N. Y.*

BABCOCK & WILCOX

BOILER DIVISION

G-791

AMSCO®

...digging

AMSCO DIPPERS

Designed for speed, heavy duty . . . Cast of 12-14% Manganese Steel to wear longer

Renewable lip — 2-piece welded designs — backhoes — Mesabi dredge types — special-purpose designs on order — complete line of accessories.

Streamlined jutting lip and fanned teeth bite up full loads at normal power. Angled bottom means less crowd, reduces heeling, makes digging fast and easy.

You get extra wear because they're cast of tough Amsco manganese steel—work-hardening, abrasion resistant. It won't break. Resists cracking. Weighs no more than comparable fabricated dippers, same capacity.

Special features include: (1) rubber-cushioned door (optional); (2) plug-welded side seams; (3) integrally cast lugs on dipper backs; (4) cast-in pin connecting lugs; (5) interchangeability of repair parts.

Write for *Amsco Power Shovel Equipment* booklet to be available soon, containing complete details for all types.

Amsco backhoes feature the faster, easier-digging, streamlined design common to all Amsco dippers . . . plus the high strength and wear resistance of manganese steel.

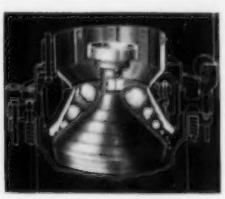
Amsco lightweight, two-piece, welded dippers take heavy-duty digging shift after shift . . . withstanding abuse, conserving power, making every load a *full* load.

AMSCO crusher and breaker parts

Won't break! Work-harden under impact! Cast of "toughest steel known"!

Amsco makes manganese steel crusher and breaker parts for most major manufacturers of crushing, grinding and pulverizing equipment. Improved resistance to wear because the surface of manganese steel work-hardens under repeated impact up to 500 Brinell. Yet, beneath the working surface, the metal remains strong and ductile, able to give slightly under crushing forces . . . absorbing abuse, resisting cracking or chipping, even when worn thin. *Buy your replacement parts from your crusher manufacturer to be sure of getting Amsco manganese steel.*

Amsco manganese steel ball mill liners work-harden to a degree that further abrasion only polishes the hard surface of the metal, reducing wear rate tremendously.



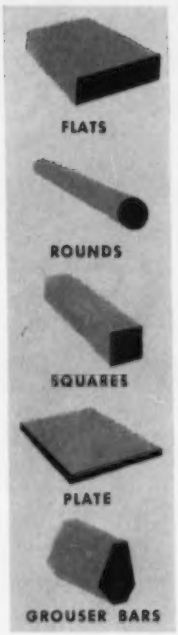
Amsco crusher concaves and mantles add extra service life to cone crushers of all types.

crushing, wear-fighter line

EASY TO WELD

AMSCO SHAPES—REPOINTERS cast of 12-14% manganese steel

Reinforce points of extreme wear with work-hardening Amsco 14% manganese steel shapes. Truck beds, chutes, crushers, blades, dipper interiors . . . wherever impact and abrasion cause early wear-out. Amsco shapes are easy to weld, manganese to manganese, or manganese to carbon steel. Size range is complete to fit all equipment.



Wear-Sharp repointers*

Work up to 6 times longer than standard repointers. Corners won't blunt. Entire leading edge wears evenly.

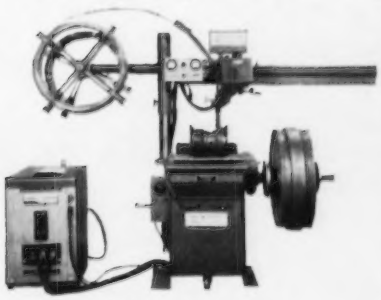
Repointer bars

Three-foot bar lengths. Also ideal for rebuilding worn lips of all digging equipment.

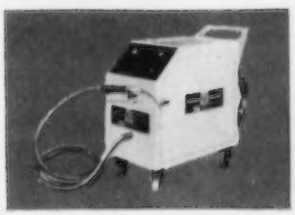
Cast-to-shape repointers

For fast, easy repointing of teeth used in less severe digging. Applied in 15 minutes, using only two electrodes.

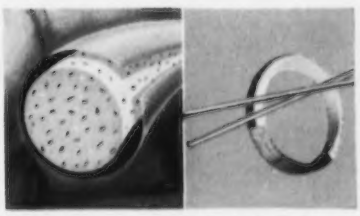
FULL WEAR-FIGHTER LINE OF AMSCO HARDFACING WELDING EQUIPMENT AND MATERIALS



Automatic welders



Semi-automatic MF welders



Manual, automatic rods & electrodes

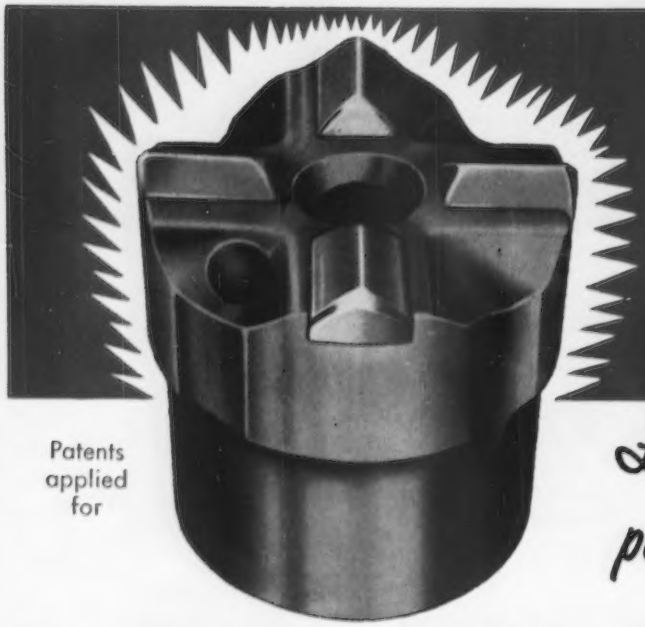
Now you can get a hardfacing material to lick every type of wear. Impact alone! Impact plus abrasion! Abrasion alone! Amsco's line is complete and includes the new high-speed, more economical *tube rod* for semi-automatic build-up and repair. You'll save hours of down time, reduce welding time and materials cost . . . plus extending service life of your equipment . . . by using Amsco machines and hardfacing materials. Write for a complete description of this wear-fighter line.

*REG. U. S. PAT. OFF.

AMERICAN Brake Shoe COMPANY

AMSCO

AMERICAN MANGANESE STEEL DIVISION
CHICAGO HEIGHTS, ILLINOIS



Patents applied for

Now for A TUNGSTEN

"drilled to destruction

Lower first cost... Low cost per foot of hole drilled with

LIDDICOAT

the new bit you have heard and read about

Forged for Toughness

The Liddicoat Tee Cee bit body is produced entirely by forging. By a patented and exclusive manufacturing process, the hot alloy steel is subjected to tremendous pressure which extrudes the steel in the desired shape. This method preserves the important grain of the steel, flow lines being compressed rather than cut across as is usual in forgings of this type. The retention of the unbroken grain and the compression of the steel provides Liddicoat bits with an unusually strong tough body.

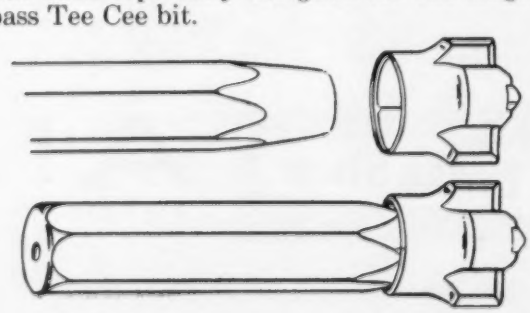
Longer Life from Interesting New Insert

In examining the Liddicoat Tee Cee bit, you will note the shallow tungsten carbide insert (patents applied for). It is the design of this insert that provides the unusual performance of the Tee Cee bit.

Experience with the conventional multi-use insert bit indicates that the bit will usually dull at a given footage,the distance, of course, depending on the type of rock. The dulling point of the multi-use carbide bit is not to be considered as the life of the Liddicoat single-use Tee Cee bit, for experience proves that the Liddicoat "used to destruction" Tee Cee bit drills far beyond the average dulling point of the multi-use Carbide bit.

Taper Socket–No Threads – Fast, Firm Attachment

The type TS Tee Cee Liddicoat (no resharpening) bit has a completely new taper socket connection. Within the socket of the bit is a brass shim. The socket, which is completely forged, is tapered to correspond to the taper placed on the drill rod. The connection assures an absolute attachment to the rod, and yet permits easy removal. The taper socket has been especially designed for the single pass Tee Cee bit.



the first time

CARBIDE INSERT BIT

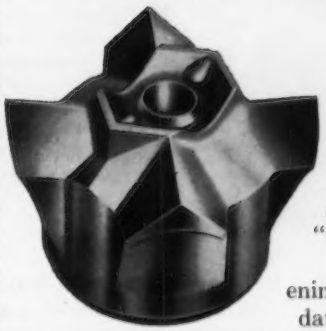
without need of resharpening"

For those who use steel bits

The Fast Drilling

LIDDICOAT STEEL BIT

"used to destruction – no resharpening"

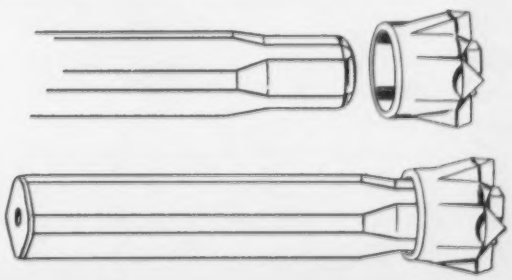


The Liddicoat steel bit is one of the first detachable bits made for "use to destruction without resharpening." Early patents date back more than twelve years. Through years of experience in the use and production of millions of bits, Liddicoat has reached a high state of perfection and popularity.

The Liddicoat bit is forged from steel made to our exact specifications. Provided in the design are unique high performance features which cannot be designed into the conventional multi-use bit, which has to be resharpened. The outstanding features of the Liddicoat bit are the pilot construction and wing design. The pilot chips the rock ahead of the cross wing and eliminates the pulverizing action common to the conventional cross bit. Of prime importance is the strong attachment without threads.

Method of attachment

Diagram (right) shows the Liddicoat Drill bit, before and after attachment, where quarter octagon steel is used. In such case, the "wings" of the bit line up with the corners of the rod, the flat sides within the bit socket being the "wings." The machine blow completes bit seating. The harder the rock, the tighter the lock.



WESTERN

Rock Bit Manufacturing Company

552 West 7th South • Salt Lake City 4, Utah

NORDBERG MACHINERY

...engineered for large volume, quality production of ores and industrial minerals

The entire line of heavy-duty Nordberg Mining Machinery has been engineered and built for one basic purpose . . . to meet the mining industry's expanding demand for low cost, quality production and processing of large tonnages of metallic and non-metallic ores and industrial minerals.

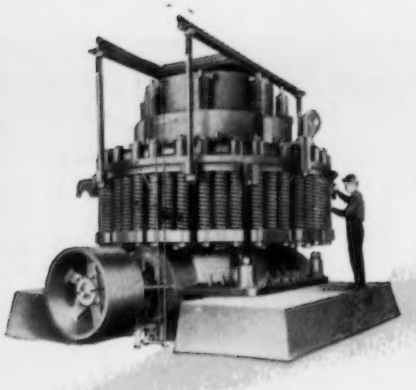
The many years of specialized experience gained by Nordberg in working closely with the mining fraternity has resulted in continual design and operational improvements which have consistently made Nordberg Machinery first choice among the world's leading ore and mineral producers.

As illustrated, Nordberg Mining Machinery includes Symons® Gyratory Crushers for primary breaking, Symons Cone Crushers for secondary and tertiary crushing, Nordberg Mills for wet or dry grinding, Symons Vibrating Grizzlies and Screens for scalping and sizing, and Nordberg Engines for mine and mill power.

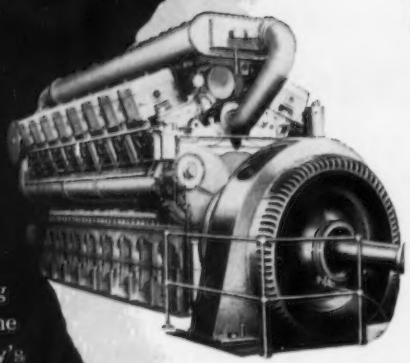
Write for literature on the Nordberg Machinery you need to efficiently produce large tonnages of ores and industrial minerals at lower cost per ton.

SYMONS — A Registered Nordberg Trademark known throughout the world

NORDBERG MFG. CO.
Milwaukee, Wisconsin



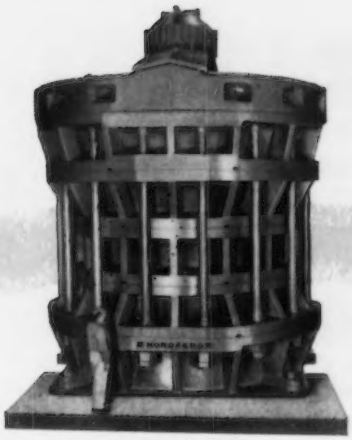
SYMONS CONE CRUSHERS
Built in both Standard and Short Head types, in sizes from 22" to 7' in diameter, in capacities from 6 to 900 or more tons per hour.



NORDBERG ENGINES
Ranging from small power units to large stationary engines. Nordberg engines are built in types for Diesel, Duafuel® and Spark-Ignition Gas operation, in sizes to over 12,000 horsepower.

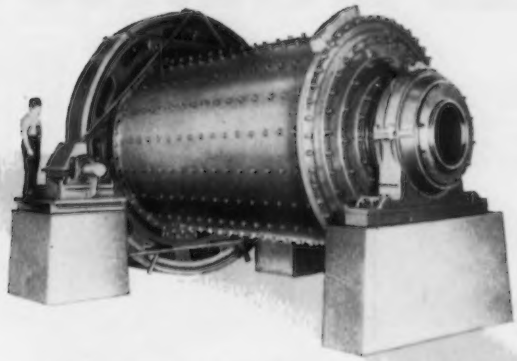
SYMONS ROD DECK SCREENS
Highly efficient screening surface of spring steel rods—easily replaced. Especially suited for wet, sticky materials.

© 1957, Nordberg Mfg. Co.



SYMONS® PRIMARY GYRATORY CRUSHERS

Built in 30″, 42″, 48″, 54″, 60″ and 72″ feed opening sizes, for capacities to 3500 or more tons per hour.

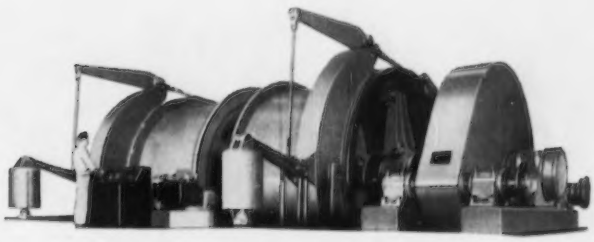


NORDBERG GRINDING MILLS

Built for wet or dry, open or closed circuit operation . . . including Rod, Ball, Pebble, Tube and Compartment types, in sizes from 6′ to 13′ dia., up to 50′ in length.

NORDBERG MINE HOISTS

Built in both friction and drum types for hoisting both ore and men. These dependable hoists are widely used in large coal and metal mining operations.

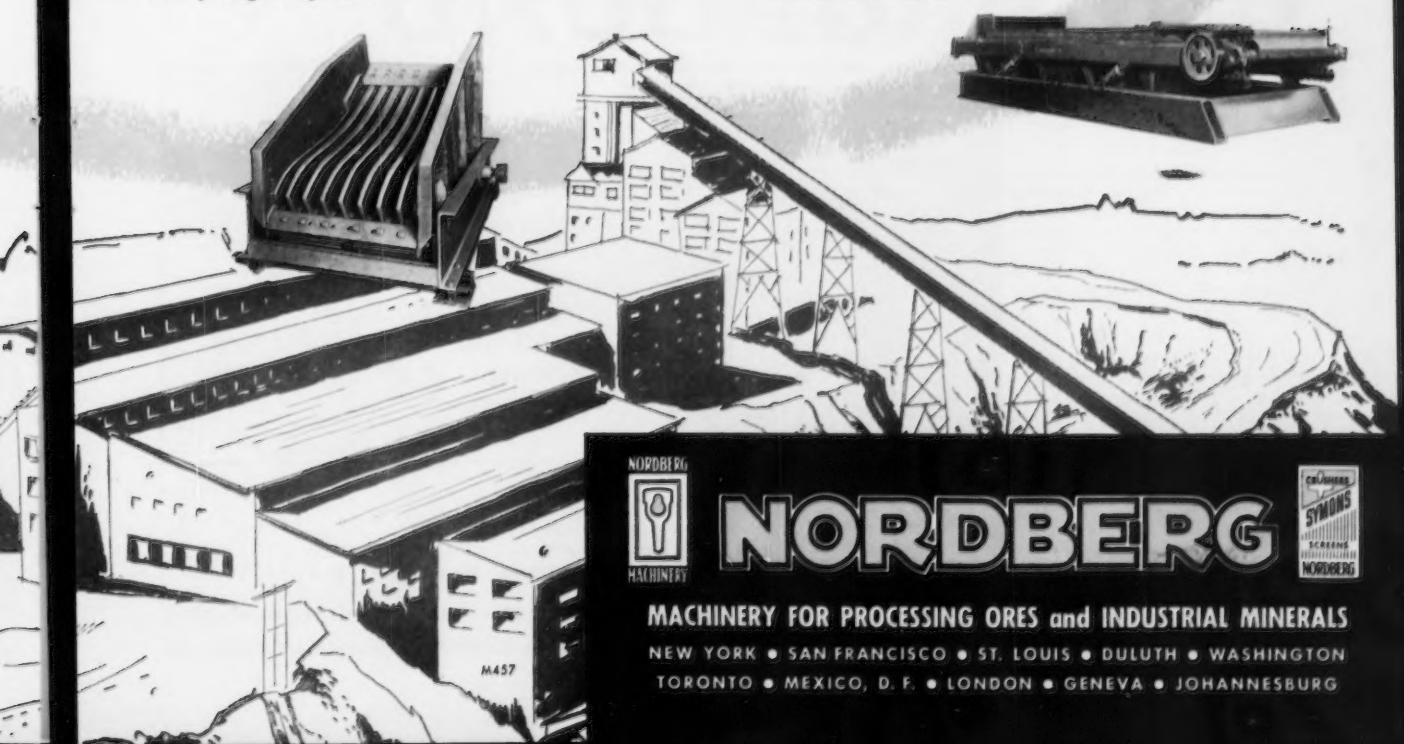


SYMONS VIBRATING BAR GRIZZLIES

Built for heavy duty large capacity primary scalping service. Particularly effective when handling wet, sticky or gummy ores.

SYMONS HORIZONTAL VIBRATING SCREENS

Permit level, large capacity screening of extreme accuracy. Built in single, double and triple deck types in a wide range of widths and lengths.



NORDBERG MACHINERY

NORDBERG

SYMONS SCREENS NORDBERG

MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

NEW YORK • SAN FRANCISCO • ST. LOUIS • DULUTH • WASHINGTON

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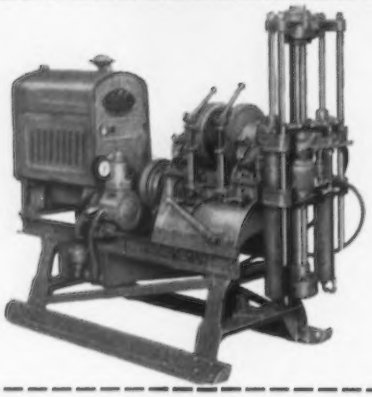
EXPLORATORY



Versatile Skid-Mounted CP Core Drills—are also available without skids for truck or jeep mounting. Air, electric, gasoline and diesel drives. Capacities to 2250 feet with E—EX fittings.

OPEN PIT

Self-Propelled G-800 Tracdril — mounts either a hard-hitting 4″ or 4½″ deep hole drill in standard, or standard-neutral-reverse rotation types.
OTHER OPEN PIT EQUIPMENT: Hydraulic Boom Arms (can be mounted on your tractor); CP Rotauger (can be mounted on G-800 Tracdril or tractor for rotary drilling in softer formations).

UNDERGROUND

5 Airleg Models available in *Attachable* types for conversion of standard sinkers to airleg operation and in *Integral* types for production drilling. In feed lengths of 36″ and 48″. OTHER UNDERGROUND EQUIPMENT: CP Rotaugers; Stopers; Drifters, Hand Held Sinkers.

Chicago Pneumatic *8 East 44th Street, New York 17, N. Y.*

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

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EIMCO ROCKERSHOVELS AND AIR LOCOMOTIVES

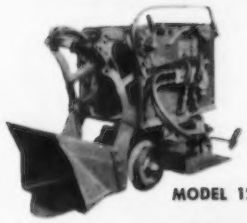
MODEL 12B — Air or electric powered. Loading speed 20 to 35 cu. ft. per min. Dimensions: Width 28". Caging Length (bucket down) 73"*. Head room 78½"*. Clean-up range 83"†. Weight 4500 lbs. Track gauges 15" to 36".
*Standard †Without side plow

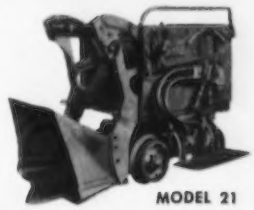
MODEL 21 — Air or electric powered. Loading speed 35 to 50 cu. ft. per min. Dimensions: Width 33½". Caging length 55". Length (bucket down) 87"*. Headroom 88"*. Clean-up range 98"†. Weight 7200 lbs. Track gauges 18" to 48".
*Standard †Without side plow

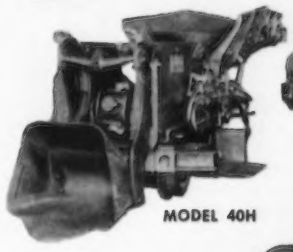
MODEL 40H — Air or electric powered. Loading speed 60 to 100 cu. ft. per min. Dimensions: Length (bucket down) 20'8½". Headroom 8'0". Belt width 28". Clean-up range 12'. Weight 16,850 lbs. Track gauge 28" to Std. Railroad. Wide gauge can be built to tram on 24" gauge.

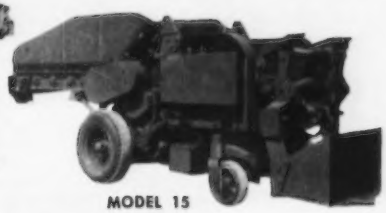
MODEL 15 — Electric or gasoline powered. Rubber tired. Hopper or conveyor. Loading speed 20 to 40 yards per hour. Dimensions: Width 5'9". Length 10'2". Weight with hopper 8000 lbs., with conveyor 9310 lbs.

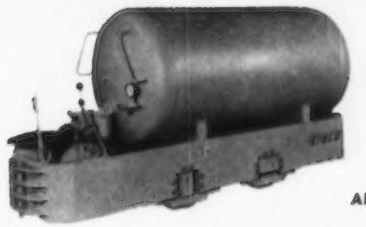
AIR LOCOMOTIVES — Two speed constant mesh transmission. Inspected and serialized to meet A.S.M.E. unfired pressure vessel code. Two sizes. Dimensions: Receiver size 32" x 84"(1) or 40" x 84"(2). Width 32"(1) or 40"(2) Height above rail 48½ (1 or 2). Wheelbase 30" (1 or 2). pressure psi 110 (1 or 2). Weight 2790 lbs. (1) or 3260 lbs.(2).


MODEL 12B

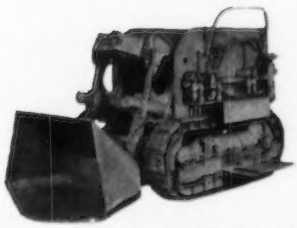

MODEL 21

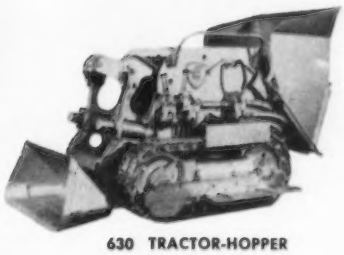

MODEL 40H

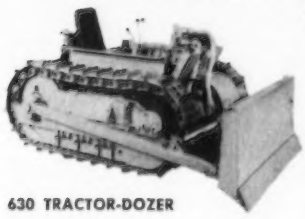

MODEL 15


AIR LOCOMOTIVES

EIMCO 630 TRACTOR SERIES


630 TRACTOR-EXCAVATOR


630 TRACTOR-HOPPER


630 TRACTOR-DOZER

630 TRACTOR-DRILL

630 TRACTOR-EXCAVATOR — Designed for trackless operation underground. Air or electric powered. Independent control of each track. Available with an assortment of attachments. Loading speed 600 to 800 tons per shift. Headroom 6'8". Width 5'8⅝". Length (bucket down) 9'4".

630 TRACTOR-HOPPER — Standard 630 Tractor-Excavator fitted with an integral hopper at the rear of the Excavator. Used where short hauls are required or bulk material is to be moved to a hopper at floor level. Hopper can easily be adjusted for automatic opening and closing. Weight complete 12,000 lbs. Hopper capacity 32 cu. ft. Overall length (bucket down) 10'6". Hopper width 4'6½". Overall operating width 5'8⅜".

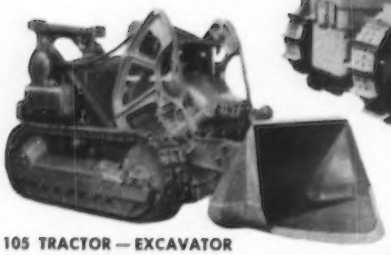
630 TRACTOR-DOZER — Air or A. C. Electric powered tractor with special straight blade dozer attachment. Dozer blades are equipped with screw type blade pitch and tilt adjustment and replaceable cutting edges. Track oscillation does not effect blade position and blade movement is by positive gear drive. Overall height 45". Overall width 62". Overall length 91⅛". Weight complete 7,980 lbs.

630 TRACTOR-DRILL — Standard 630 Tractor that can be fitted with a variety of drilling attachments. All parts are of heavy-duty alloy cast steel. Highly maneuverable, with independent control of each track. Tractor dimentions (without attachments). Overall height 45". Overall length 71⅞". Overall width 55". Weight complete 6,500 lbs. Drawbar pull at zero track slippage 10,600 lbs.

EIMCO 105 TRACTOR SERIES

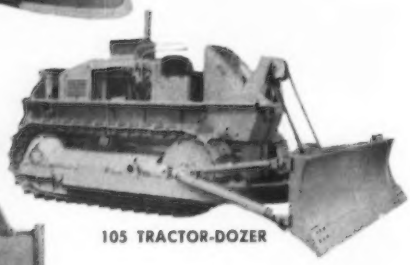
105 TRACTOR

105 TRACTOR — 125 or 143 HP diesel powered prime mover — available with bulldozer, loader and other attachments. Front and rear power take-off's. Independent control of each track. Exclusive Unidrive transmission which eliminates all manually operated clutches. Up front operator position for full visibility. Dimensions: Height 9'5¾". Length (base)12'6". Track gauge 74". Weight 28,000 lbs. Maximum drawbar pull with sufficient weight 55,000 lbs.



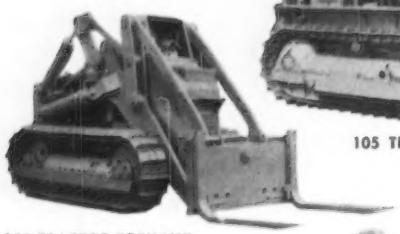
105 TRACTOR — EXCAVATOR (OVERHEAD)

105 TRACTOR-EXCAVATOR — 105 Tractor with overhead loader attachment. Designed for heavy-duty loading and excavating work of all types. Loading speed 6 to 8 cu. yds. per min. Headroom (std.) 13'2". Length (bucket down) (std.) 15'0". Track gauge 74". Weight 38,500 lbs.



105 TRACTOR-DOZER

105 TRACTOR-DOZER — Standard 105 Tractor equipped with either a straight blade (10'4" width) or an angle blade (13'0" width) attachment. Available with hydraulic blade control, single or double drum cable control, or a combination of hydraulic and cable controls. Other attachments or accessory equipment with standard S.A.E. drilling are easily mounted at front or rear power take-off's.



105 TRACTOR-FORK LIFT

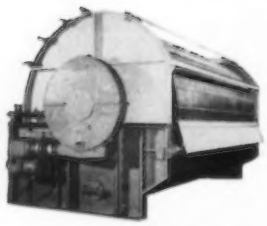
105 TRACTOR-FORK LIFT — 105 Tractor mounted with heavy-duty front end fork lift attachment. Rugged construction throughout. Oversize lift and tilt cylinders with built-in shock and relief valves for both directions of operations. Low hydraulic working pressure (650 psi). Hardened pins and bushings at all joints. Capacity at carry position 20,000 lbs. Capacity at full lift 15,000 lbs. Fork height (full lift) 14'6¼". Overall length (fork down) 19'9½". Weight complete 44,000 lbs. Hydraulically actuated tilting adjustment, keeps fork attachment on horizontal plane when loading in rough uneven areas.

105 TRACTOR-FRONT END LOADER

105 TRACTOR-FRONT END LOADER — Standard 105 Tractor mounted with an extra heavy-duty loader attachment. Total length (bucket down) 17'4". Bucket capacity 2½ cu. yds. Bucket height (full lift) 14'6¼". Maximum breakout force 40,000 lbs. Maximum lifting capacity at cutting edge 25,000 lbs. Capacity at carry position 20,000 lbs. Capacity at full lift 15,000 lbs. Average bucket cycle, raise-dump-return 15 sec. Weight complete 44,000 lbs.

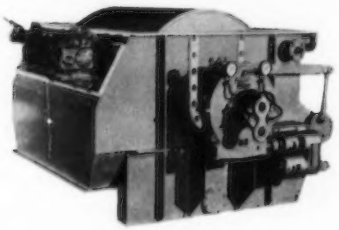
EIMCO FILTERS

DRUM FILTER — Features individual design. Provides deep drainage sections, greater piping area and large streamlined valves. Construction materials vary with material filtered and local operating conditions. Face length 2'0" to 18'0". Drum diam. 4'0" to 12'0". Other sizes made to specifications.



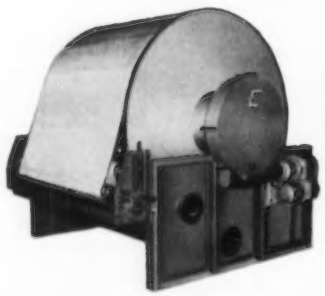
DRUM FILTER

PRECOAT FILTERS — Available for open, vapor and pressure tight requirements. Can be converted from open to vapor or pressure tight units in the field without changing existing units. Materials to specifications. Face length 2'0" to 16'0". Drum diam. 4'0" to 8'0".



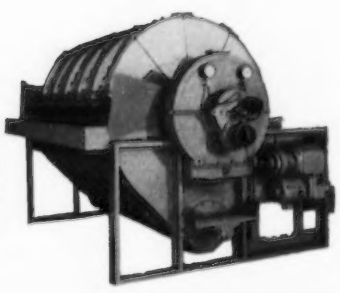
PRECOAT FILTER

ROTOBELT — Drum type filter designed with a cloth or woven stainless steel filter medium, in belt form. Medium edges are sealed for absolute minimum vacuum requirements in cfm per sq. ft. area. Belt Cycle; 1 - belt leaves drum. 2 - passes on to cake discharge roller. 3 - through washing compartment (filter medium is completely washed each revolution). 4 - onto return rollers. 5 - return to drum. Face Length 1'0" to 14'0". Drum Diameter 0'18" to 14'0".



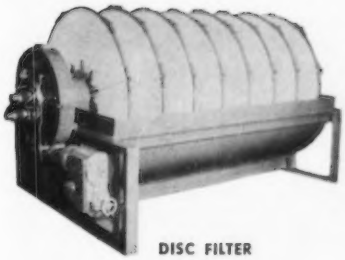
ROTOBELT

AGIDISC FILTERS — Designed for a comparatively wide range of particles in suspension, where the density of feed is lower and settling is rapid. Construction materials for filter and disc sectors vary with materials filtered and local operating conditions. Number of discs 1 to 12. Disc diam. 4'0" to 12'6". Other sizes made to specifications.

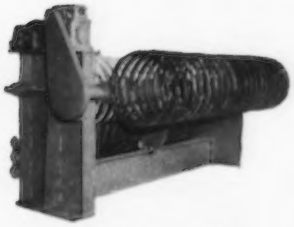


AGIDISC FILTER

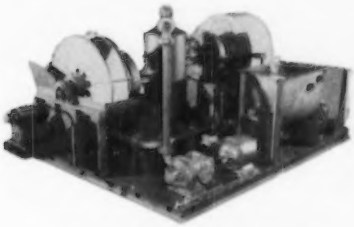
EIMCO FILTERS



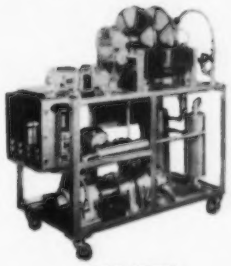
DISC FILTER



EIMCO-BURWELL FILTER

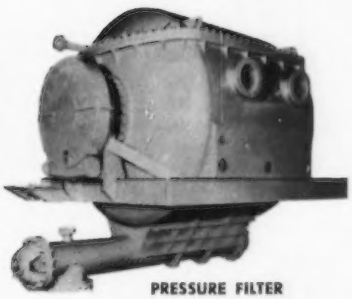


PLATFORM FILTER STATION

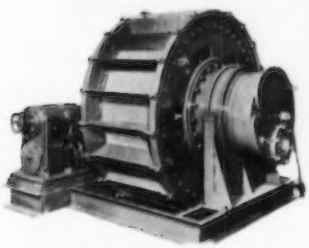


LAB FILTER

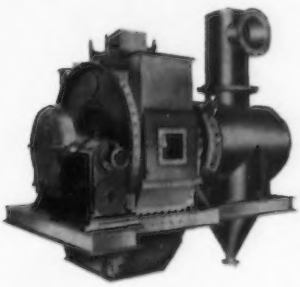
PAN FILTER



PRESSURE FILTER



DEWATERER



DRYER

DISC FILTERS — Designed according to slurry characteristics. Construction materials for filter and disc sectors vary with materials filtered and local operating conditions. Number of disks 1 to 12. Disc diam. 4'0" to 12'6". Other sizes made to specifications.

EIMCO-BURWELL FILTERS — Designed with two sets of circular frames, each pair mounted at 180° of each other on a common shaft. One frame is always ready for operating. While the other is extended in cleaning position Number of frames 2 to 30. Frame thickness sizes 1", 1½", 2½", and 3".

PLATFORM FILTER STATIONS — Constructed on a structral steel subbase and available with drum, disc, pan, pressure, or plate and frame units for pilot plant or small filter stations. Auxiliary equipment: receivers, vacuum and filtrate pumps, blower, motors, piping and central control panel.

LAB FILTERS — Drum or disc units specially constructed on a flat platform or in a cabinet, which includes all necessary operating equipment for a pilot plant or laboratory filter station. Construction materials to specifications.

PAN FILTER — Particularly suited to sluries having 10% or more solids consentration with medium to fast setting and a wide range of screen sizes. Independent compartments allow extremely sharp liquor separation between washes. Complete cake discha-ge is obtained by tilting pan compartments 160°. Sq. ft.of filter area available 10 to 240 and larger.

PRESSURE FILTER — Available with drum or disc unit inside a pressure vessel. Designed for pressure up to 150 P. S. I. and to A.S.M.E. code. Construction materials to specification. Maximum diam. 8'0" for std. drum, disc, agidisc and precoats. Dryers, max. 6'0". Cake discharge is by sealed screw conveyors or pressure tank.

DEWATERERS — Designed and especially adapted for high capacity dewatering of the slurrys with fast settling solids. Construction materials vary with material to be dewatered and installation specifications. Face length 3'0" to 6'0". Drum diam. 1'0" to 5'0". Other sizes to specifications.

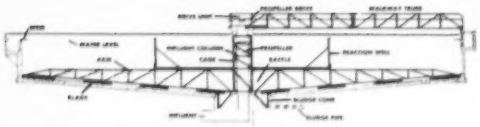
DRYERS — Designed and particularly suited for granular or crystalline materials which are fast settling in solution. Streamlined head assembly to direct heated airflow through cake and receiver. Face length 3'0" to 6'0". Drum diam. 1'0" to 5'0".

RESEARCH AND DEVELOPMENT CENTER

To further the science of Solids-Liquid separation through filtration, The Eimco Corporation established its Filtration Research and Development Center at Palatine, Illinios. These new, modern, completely equipped facilities are staffed by engineers internationally recognized as research and development authorities in the field of Solids-Liquid separation. Eimco's years of practical experience combined with the scientific findings of the Research and Development Center engineers give practical and logical solutions to all the processing industries, where filtration is an integral part of their flow sheet.

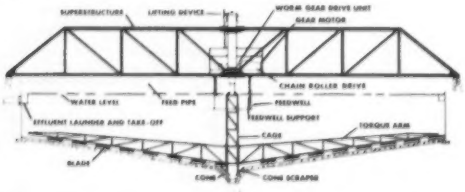
FILTER MEDIA — The snythetic and natural fabric available through Eimco are the most modern materials developed for filtration equipment in the Chemical and Processing Industries. Eimco's skilled filtration engineers will help you find the best filter medium to meet your specific filtration problems.

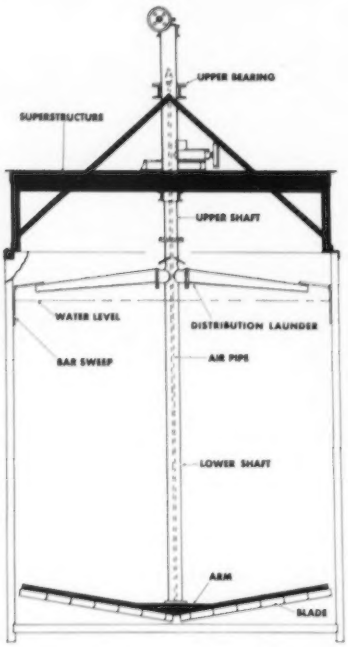
EIMCO — PROCESS EQUIPMENT



REACTOR-CLARIFIER— Eimco Process Reactor - Clarifier mechanisms are designed with mechanical or air agitation, flocculation or sludge recirculation in the center supplied in diameters up to 125 feet, are the most reliable and economical units available for water treatment, waste treatment and special flocculation - clarification services. Specific recommendations as to the size, type and materials of construction are made for each service.

THICKENERS— Eimco Process Thickener Mechanisms are available in sizes up to 325 feet diameter. Superstructure supported, center column and traction machines are made in wood, steel, rubber covered or stainless steel construction. Each mechanism is tailored for the required duty with balanced torque designed into every component to insure dependable trouble-free service on all pulps including the heaviest, fastest settling concentrates.





AGITATORS— Eimco Process Air Lift and Mechanical Agitators are supplied for tank diameters up to 40 feet. Every machine has the same rugged construction but all specific features such as the materials of construction, air requirements, air distribution, impeller type and size and rotative speed are designed specifically for the job after a thorough analysis of the operating conditions.

OTHER EIMCO EQUIPMENT

AIR MOTORS — Eimco Air Motors are five cylinder radial type motors for reversible or non-reversible service. Heavy-duty construction with special attention to streamlined air passages make the Eimco the most efficient air motor on the market.

GEARED AIR MOTORS — Eimco Air Motors are five cylinder radial type. Either flange or pedestal mounted and in a variety of gear reductions with a full range of speed reduction units. Precision made. Reversible. High starting torque. Dynamatic and static balancing for highest efficiencies and smooth operation.

AIR HOSE — Eimco Air Hose—extremely flexible wire braid. Neoprene tube that will not collapse. Natural rubber cover treated for resistance to abrasion and impact. Will not sun check. Available in sizes of ½" to 4" with or without connections.

LINERS — Utaloy Ball, Rod and Tube mill liners. An alloy cast steel, representing the ultimate in controlled microstructure. Actual job data shows that "Utaloy"liners will grind more tons per set.

BALL MILLS — Eimco cylindrical type ball and rod mills with either central overflow or grate discharge are available in a wide variety of sizes. Any Eimco mill can be converted from central overflow to grate discharge or vise-versa. Extra heavy-duty construction.

FOLDING SCRAPERS — Eimco Folding Scrapers are heavy-duty high capacity scrapers. Folding feature makes scraper require less power on return pull and dig in for full load on every trip. Cast of abrasion and impact resisting alloy steel.

AIR MOTORS

GEARED AIR MOTORS

AIR HOSE

LINERS

BALL MILLS

FOLDING SCRAPERS

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

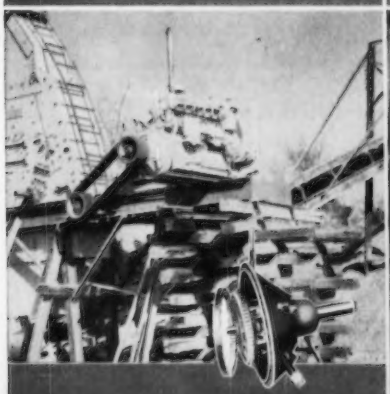
New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Tex. Birmingham, Ala. Duluth, Minn. Kellogg, Ida. Pittsburgh, Pa. Seattle, Wash.
Cleveland, Ohio Houston, Tex. London, England Gateshead, England Paris, France Milan, Italy Johannesburg, South Africa

BULLETIN AP - 19, 3-58-50M Printed in U. S. A.

CRAWLER TORQUE CONVERTER

FLUID POWER TAKE-OFF

TRUCK-TYPE TORQUE CONVERTER



FRICTION POWER TAKE-OFF

FLUID COUPLING

CL FRICTION CLUTCH

Wherever you find ORE... you also will find TWIN DISC

In mining—wherever power is applied to driven equipment—you're likely to find Twin Disc Friction Clutches or Fluid Drives.

In removing overburden, you'll find the biggest crawler tractors driving through Twin Disc Torque Converters . . . power shovels, equipped with either Twin Disc Converters or Fluid Power Take-Offs . . . and trucks incorporating Twin Disc Truck-Type Torque Converters.

In removing and processing ore, you'll find stationary power units equipped with rugged Twin Disc Friction Power Take-Offs . . . conveyor systems, receiving a *shock-cushioning* flow of power through Twin Disc Fluid Couplings . . . and drills, equipped with Twin Disc Model CL or EH Friction Clutches.

Today, Twin Disc is the world's largest exclusive manufacturer of a complete line of friction and fluid drives—for correctly linking horsepower to industrial powered equipment. Since 1918, Twin Disc *specialists* have designed and built friction and fluid drives *for that one purpose.*

If *you* have a power transmission headache—consult the Twin Disc Clutch Company, Racine, Wis., Hydraulic Division, Rockford, Ill.

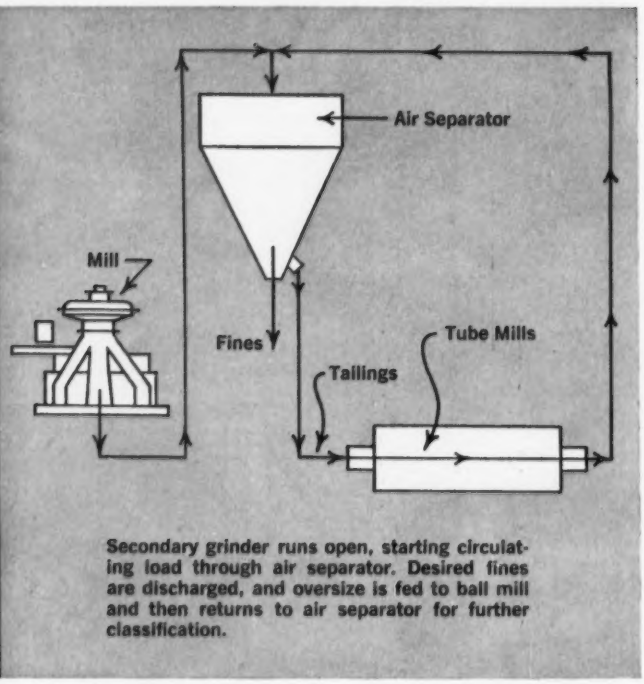
TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives

Stop Overworking Grinding Mills

FEED SPOUT
Sturtevant Air Separators come in 9 models, diameters range from 3 to 18 ft.
TAILINGS DISCHARGE
FINES DISCHARGE



Secondary grinder runs open, starting circulating load through air separator. Desired fines are discharged, and oversize is fed to ball mill and then returns to air separator for further classification.

LET STURTEVANT AIR SEPARATION HELP YOUR SYSTEM PRODUCE UP TO 300% MORE 40 TO 400 MESH FINES — CUT POWER COSTS AS MUCH AS 50%

Fines that pass through grinding mills unhindered, serving only to increase the work load, can be quickly classified by a Sturtevant Air Separator operating in closed circuit. With all oversize automatically returned for further grinding, the result is production capacity impossible to achieve in single-pass grinding — as well as a better, more uniform product.

Closed circuit grinding and air separation is of proved advantage in *all* secondary reduction processes. Grinding mills are free to perform at top efficiency, their output frequently increased as much as 300% and power costs cut up to 50% (documented by 30 years of Sturtevant air separation experience in the cement industry). Further, attritional heat is dissipated by greater surface exposure.

Sturtevant Air Separators Keep Grinding Units At Peak Efficiency — Classify Feed Loads to 800 Tons Per Hour

Sturtevant Air Separators circulate production loads with exact control of air currents and centrifugal force. Simple adjustments make possible counter-action between the two to the point where a product of almost any desired fineness may be collected while coarser sizes are rejected.

A 16 ft. Sturtevant, for example, took a feed rate of 800 tph, containing only a small percentage of desired fines, and delivered 30 tph 90% 200 mesh, recirculating the oversize through the grinding circuit. (In the cement industry, Sturtevant units deliver up to 60 tph raw cement fines, 40 tph finished cement fines.)

Sturtevant's ability to engineer precise, high capacity classification for closed circuit grinding systems is the result of long experience with a wide variety of dry processes. Sturtevant designed its first air separator some 40 years ago — and has been pioneering developments in centrifugal classification ever since.

Current users of Sturtevant Air Separators include manufacturers of sulfur, soybeans, phosphate, chocolate, feldspar, sand, pigments, limestone fillers, abrasives, plasters, ceramics and cement.

Designed for precise separation of all granular materials, Sturtevant Air Separators have been adapted to other materials as well. Johns Manville, for example, uses a 10 ft. model to separate 3 to 6% undesirable rock from asbestos.

Ruggedly constructed, Sturtevant units are designed for minimum maintenance — at a Midwestern rock-crushing plant, a 10 ft. Separator operates outdoors year-round with only routine care.

For further information, request Sturtevant Bulletin No. 087. Write Sturtevant Mill Co., 101 Clayton St., Boston 22, Mass.

STURTEVANT

Dry Processing Equipment

CRUSHERS • GRINDERS • MICRON-GRINDERS
SEPARATORS • BLENDERS • GRANULATORS
CONVEYORS • ELEVATORS

Cyanamid speaks his language

Our field engineers have worked side by side with him for more than forty years, throughout the world, wherever the mining industry operates.

We provide first-hand, in-the-mill assistance in the most efficient use of Cyanamid reagents. We help to solve difficult beneficiation problems . . . based on our comprehensive, continuing knowledge of ore-dressing advances the world over.

Ability to give mature and experienced technical assistance . . . as well as our complete line of flotation and cyanidation reagents and our long record of dependability . . . has made Cyanamid the world leader in metallurgical chemicals.

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MINING CHEMICALS DEPARTMENT
30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.

DIAMOND BITS and CORE BARRELS

Trouble-free operation—minimum maintenance—maximum core recovery. This is what you buy in Christensen coring equipment. Equipment designed for every type operation and every size drill, from portable to heavy duty types.

SERIES D-CORE BARREL

Manufactured in AX, BX, NX, size. This barrel comes in 10 ft. and 5 ft. length and takes a core ranging in size from 1.136″ dia. (AX) to 2.060″ dia. (NX). With a full floating inner tube to prevent friction grinding and minimize core wash, this barrel will recover the greatest possible amount of core even in the softer, more fractured formations. Excellent for use with lighter to intermediate weight drills.

SERIES C-2—CORE BARREL

Increased annulus between tubes, between outer tube and hole allows this barrel to be used with either water, air or oil base mud.

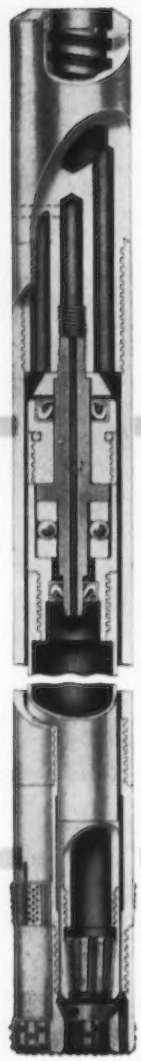
Manufactured with heavy wall tubing, this barrel is recommended for the most severe conditions. The series C-2 barrel is available in AX to NX size; comes in 20, 10, and 5 ft. lengths.*

Core size from 1.067″ dia. (AX) to 1.875″ dia. (NX). NX size is illustrated.

*AX comes in 10 and 5 ft. lengths only.

3½″ x 2⅛″ Core Barrel

This barrel, similar to our Series 250P oil field barrels, is made for use with heavy duty drills. It can be used with mud, or air, and takes a 2-1/8″ core. Available in 20, 15, 10, or 5 ft. lengths.

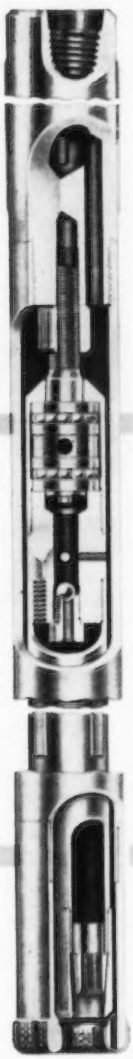


SERIES D

For conventional diamond drill using water.. Can be supplied with chrome plated inner tubes.

SERIES C-2 NX SIZE

For conventional diamond drill using air, water, or mud can be supplied with chrome plated inner tubes.



3½″ X 2⅛″

For large rotary drills using mud or air.

For complete prices and sizes on all Christenson Diamond Bits and Core Barrels, write for catalog SD-506.

Less cost per foot . . .

FOR MINING EXPLORATION

Rock differs in drillability from area to area. Although any Christensen bit will perform in any formation, you'll get optimum performance from Christensen bits designed to cut a specific type of rock. The variety of types, means there's a Christensen Bit designed to cut the rock you're drilling at "Less Cost Per Foot." Contact us.

CORE BIT—3⅛"x1⅞" Type 7328

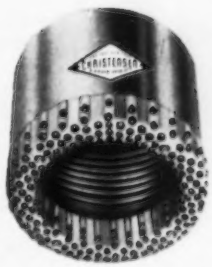
This bit is designed for use with air or mud on Christensen NXC-2 core barrel. Has six waterways, hard matrix, and 48 carats of 3 per carat size diamonds. The oversize O.D. is recommended for air circulation or for use with mud.

CORE BIT—Type 7785

This bit has been used very successfully, using compressed air or mud in drilling sandstone and shale. Has 16 waterways, 60 carats of 4 per carat size diamonds in a hard matrix. Fits Christensen 3-1/2" x 2-1/8" core barrel.

CORE BIT—Type 4746

AX series D Face Discharge Coring Bit. 4 ports. no waterways, extra hard matrix, 25 per carat diamonds, about 11.5 carats. Recommended for maximum core recovery in broken and severely abrasive rock. May be made with waterways and discharge ports.



CORE BIT—Type 2643

Ex Bevel Wall Core Bit, 2 reinforced waterways, 40 per carat diamonds, hard matrix. This bit is set with small diamonds and is recommended for moderately abrasive formations.

CORE BIT—Type 1720

AX Bevel Wall Core Bit, hard matrix, 25 per carat diamonds, no waterways, approximately 12.5 carats, used for moderately abrasive rocks, where rock is free cutting, and where maximum diamond concentration is desired.

Christensen Diamond Products also manufacture casing shoes, casing bits, reaming shells, and drilling bits. For complete information, write for catalog SD506.

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CHRISTENSEN
DIAMOND PRODUCTS

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Manufacturers of a Complete Line of Quality Gear Drives and Flexible Shaft Couplings for Industry

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The helical and spiral bevel gears used in Falk gear drives assure highest attainable mechanical efficiency — 98½% per gear train under full load.

ALL-MOTOR MOTOREDUCERS *Package drives up to 75 hp capacity.*

A Falk All-Motor unit may be used with any standard foot-mounted motor within the rated capacity of the gear unit. Standard output speeds from 1.2 to 520 rpm (with 1750 rpm motors); ratios as high as 54,000:1 in semi-standard designs. All-steel construction. Integral units also available in the range from 1 to 40 hp.

Ask for Bulletin 3100.

SHAFT MOUNTED DRIVES *Up to 40 hp.*

Horizontal or Vertical Units

V-belt or chain connected to prime mover. Single and double reduction all-steel units in seven sizes provide choice of wide range of output speeds between 420 and 5 rpm. Maximum torque rating at low speed shaft: 31,000 lb-in.

Ask for Bulletin 7100.

SMALL SPEED REDUCERS *Up to 138 hp.*

◄ **Concentric Shaft** Ratios from 1.5:1 to 969:1. Max. torque rating at low speed shaft: 53,000 lb-in.

Right Angle ►

Ratios from 5:1 to 1459:1. Max. torque rating at low speed shaft: 73,000 lb-in.

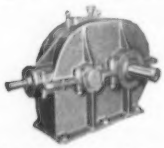
Ask for Bulletin 1105.

LARGE SPEED REDUCERS *Up to 3500 hp.*

Parallel Shaft

Up to 3500 hp. Ratio range: from 2:1 to 300:1. Max. catalog torque rating at low speed shaft: 1,950,000 ib-in.

Bulletin 1110B.



Right Angle Horizontal

Up to 1000 hp. Ratio range from 1.5:1 to 515:1. Max. catalog torque rating at low speed shaft: 569,000 lb-in.

Bulletin 2105A.

Right Angle Vertical

Up to 760 hp. Ratio range from 6:1 to 430:1. Max. catalog torque rating at low speed shaft: 714,000 lb-in. (Shafts up or down.)

Bulletin 2110B.

HIGH SPEED DRIVES *Reducers and increasers.*

◄ **Up to 225 hp.**
Maximum rpm — approx. 4500.
Bulletin 1106.

Up to 5000 hp. ►
Maximum rpm — approx. 9000.
Bulletin 5105.

Special GEAR DRIVES *for any application.*

Special HIGH SPEED DRIVES *. . . over 50,000 rpm.*

Marine PROPULSION DRIVES *turbine and diesel driven*

Falk Flexible Shaft Couplings protect the machines they connect.

STEELFLEX COUPLINGS

34 sizes covering a hp range from ½ through 72,000 hp at 100 rpm. Torsionally resilient grid-groove design cushions impact and starting loads as much as 30% and accommodates reasonable degrees of shaft misalignment which may occur between regular inspections.

Ask for Bulletin 4100.

BASIC TYPE F for 9 out of 10 applications, horizontal or vertical. Also dual-purpose designs for torque control, brake-wheel service, piloted shafts, etc.

AIRFLEX COUPLINGS

15 sizes covering a range from 5 through 2400 hp at 100 rpm. Ideal for applications which have irregular torque characteristics in driving or driven machines (internal combustion engines, compressors, etc.).

Ask for Bulletin 8100.

Designed for mounting shaft-to-shaft, shaft-to-flywheel, or shaft-to-flange.

FALK SINGLE HELICAL AND HERRINGBONE GEARS

Designed for any industrial application. Falk exclusive full-depth tooth form provides greater load-carrying capacity. AGMA ratings.

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Diameters up to 18 ft.
Face Widths up to 6 ft.

Diametral Pitch — ¾ to 6 dp.

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Hub or ring gears in solid or split designs.

Ask for Engineering Reports 6170 & 6171.

Hub Gears

Ring Gears

Mill Pinions

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From advance reconnaissance to mine development...

GEOLOGICAL CONSULTANTS

In their more than 65 years of experience, Longyear geologists have contributed toward the location and development of some of the richest ore reserves known.

PHOTOGEOLOGY

With the aid of Longyear Photogeology (an expert, anaglyphic interpretation of aerial photos), vast and remote areas can be explored economically.

CONTRACT DRILLING

Experienced Longyear drill teams, working with finest equipment made, lend efficiency, economy and speed to any core drilling operation.

WIRE LINE CORE BARREL

Hailed as "one of the greatest advances in exploratory drilling in 50 years," this revolutionary Longyear tool permits the recovery of core while the drill rods remain in the hole.

Longyear consultants, drill crews and equipment

AIR LEG CORE DRILL

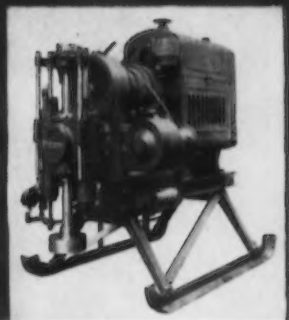
A new approach to short-hole underground core drilling, the Longyear Hi-Speed Air Leg drill requires no spraging or bracing. One man can operate with E or XRT rod to 60 feet.

PROSPECTOR HI-SPEED AIR DRILL

This powerful Longyear underground air drill is column mounted with capacity for 500' of EW rod—400' of AW rod. Other powerful column drills available.

THE LONGYEAR "24"

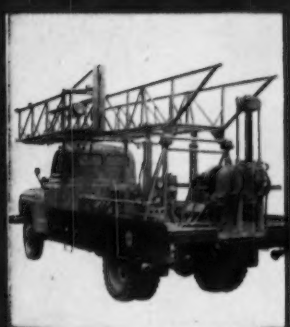
The "24" offers dependability and economy for mineral exploration and soil sampling. Available with screw or hydraulic head, skid or jeep mounted. Rated 750 feet of EW rod.



LONGYEAR JUNIOR STRAITLINE

A heavy duty drill, capacity for 1250 feet of EW rod, 750 feet NW, the "Junior" is popular the world over. Available with skid mount or jeep, truck or trailer.

offer a complete service to the mining industry

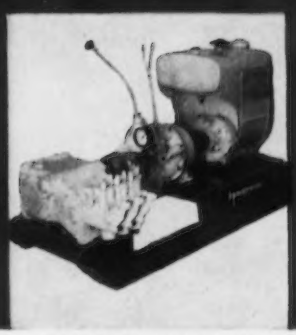


TRUCK-MOUNTED "44"

A powerful mobile drilling unit with drill and transmission pump powered by truck engine. Also available for skid and trailer mounting.

THE 314 PUMPING UNIT

One of a wide range of Longyear single speed pumps available to meet many pumping requirements. The "314" produces 14 gpm at pressures up to 300 psi.



THE 535-RQ PUMPING UNIT

Longyear transmission pumps give driller control over volume, let him drill with closed circuit at every stage. The 535-RQ has five speeds, pumps 35-4.5 gpm at pressures to 500 psi.

LONGYEAR DIAMOND BITS

More than 65 years of drilling in every type of formation contributed to the design of a complete line of diamond bits with long life for lower diamond cost per foot drilled.

E. J. Longyear Co. MINNEAPOLIS, MINN. · CABLE LONGCO

CANADIAN LONGYEAR LTD., NORTH BAY, ONTARIO · LONGYEAR ET CIE., PARIS, FRANCE

underground or open pit...

JOY HAS THE EQUIPMENT YOU NEED FOR *Economical* MINING

Whatever your mining methods, you need equipment that will reduce your cost per ton. As the world's largest manufacturer of mining equipment Joy has more years of engineering and production experience . . . designs and produces the most modern equipment for the latest in mining methods.

Select the equipment in which you are most interested . . . and write *today* for informative bulletins . . . ask for Data File 180-4.

SLUSHERS Models, two and three drum, from 5 to 150 HP. Air or electric drive. Rope pulls to 17,700 lbs. Also single drum, portable hoists—air or electric drive with capacities to 3500 lbs.

SHEAVE BLOCKS Famous for non-removable locking pin. Sizes from 6 to 20 inches—rope sizes from ½" to 1¼".

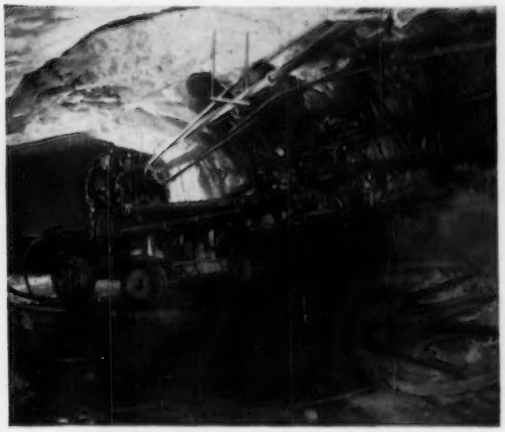
CORE DRILLS Skid column or truck mounted models for underground and surface drilling. Capacities from 250 to 2250 ft. Also a complete line of supplies.

AIR LEG Powerful, easy to handle. All controls in drill backhead for one-hand operation. Feed lengths from 36" to 72".

JUNIOR CHALLENGER BLAST HOLE DRILL CTM-1 Mounts 4½" drill —holes to 4"—completely power operated.

CHALLENGER BLAST HOLE DRILL TWM-5 Self-propelled—mounts 5¼" drifter—holes to 5" diameter, 40 ft. or more in hardest formations.

60-BH CHAMPION BLAST HOLE DRILL—Newest of the champions with hole size increased... 9" holes with round drill pipe.



DRILLMOBILES Rubber tired, self propelled jumbo with T-350 drills on Hydro Dill Jibs. Eight models air, diesel, or electric driven.

TUNGSTEN-CARBIDE ROCK BITS Complete range of sizes. Threaded or taper attachment.

SUPER HEAVYWEIGHT CHAMPION BLAST HOLE DRILL 60-BH Self propelled rotary air blast drill holes from 9" to 12".

SHUTTLE CARS . . . 14-RC Designed for hard rock mining . . electrically operated, hauls 15 tons up a 34½° grade. Diesel-mechanical version also available.

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For details write ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Write for FREE Data File 180-4

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Continuous Miners, Mobile Loaders, Shuttle Cars, Shuttle Car Elevators, Cutters, Cutting Machine Trucks, Drills, Conveyors, Belt Feeders, Post-Pullers, Timber Setters, Bits, Mine Fans, Portable Blowers, Mine Air Compressors, Roof Bolting Drills, Hoists, Core Drills, Core Drilling by Contract, Safety Circuit Centers, Cable Connectors, Vulcanizers, Rock Drills, Rock Bits, Hydro Drill Jibs, Air Compressors, Portable Lighting Lines.

WSW-M6679-180

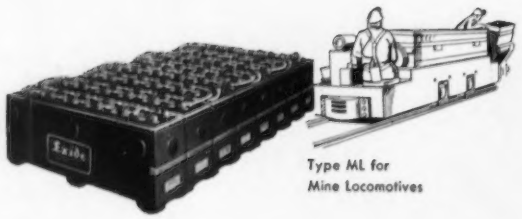
Exide INDUSTRIAL DIVISION, The Electric Storage Battery Company, Philadelphia 2, Pa.

Exide®-IRONCLAD BATTERIES—

speed hauling, reduce costs

Want to cut your mine vehicle operating costs—boost productivity? Install Exide-Ironclad Batteries. These heavy-duty units give you that extra reserve of power that lets you make more trips per shift, get more production per man-hour, haul as much the last hour as the first. And because of their proven long life, even in the most severe service, they effectively reduce the cost of your battery power.

Make sure you are getting the maximum possible utility from your mine vehicles. Specify Exide-Ironclad Batteries. Available in a range of sizes to cover the requirements of every application.



Type ML for
Mine Locomotives

EXCLUSIVE EXIDE-IRONCLAD ADVANTAGES:

Tubular construction of the positive plates is unique with Exide-Ironclad Batteries. Here's what this exclusive feature means to you:

⅓ greater effective plate area—power to spare for peak loads as well as a dependable source of power for continuous loads.

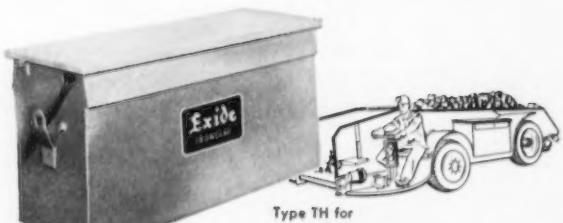
Longer plate life—active material is held firmly captive inside cylindrical power tubes, maintains electrical contact, can't shear off during cycling.

Pools of electrolyte next to plates—speed response to heavy load demands, insure maximum power from battery at all times, without delay.

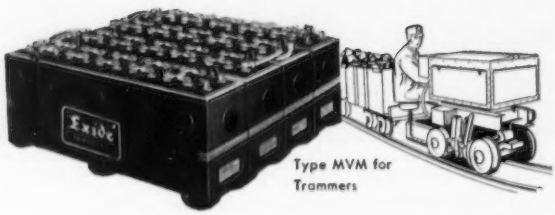
Silvium grids—exclusive patented Exide grid alloy resists corrosion, prolongs strength and thickness of grids, stretches battery life.

Vibration resistant—active material protected from shedding by cylindrical tubes, tiny openings let electrolyte in but keep active material from falling out; battery lasts longer in high vibration applications.

More active oxides—increase battery capacity, give Exide-Ironclad Batteries more power per pound; hence they have greater electrical efficiency.

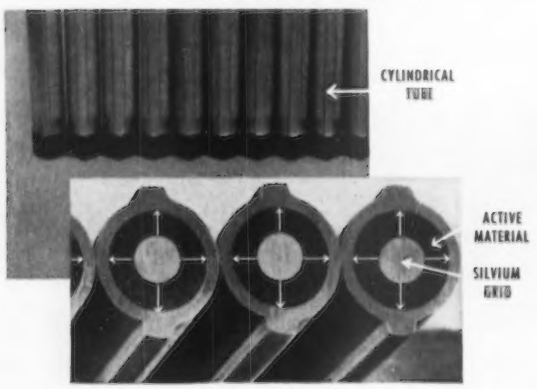


Type TH for
Shuttle Cars



Type MVM for
Trammers

Exclusive tubular construction of the Exide-Ironclad positive plate



For prices, specifications or free manual on maintaining motive power batteries, call or write the Exide sales office near you.

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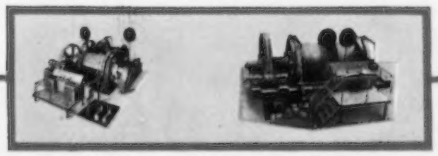
over 65 years of service to mining

Vulcan-Denver

CUSTOM ENGINEERED and STANDARD EQUIPMENT

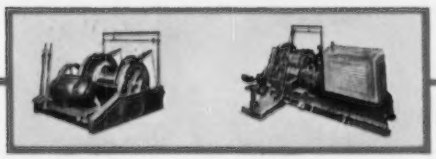
FEATURES and APPLICATIONS

HEAVY DUTY HOISTS



Custom built for special conditions at 15,000 to 30,000 lbs. rope pull. Radial acting dental clutches; brakes and clutches air or oil operated. Electrical control and safety equipment. For high production use.

LIGHT DUTY HOISTS



Custom engineered to conditions, for installations requiring 1,250 to 15,000 lbs. rope pull. Choice of motive power, safety and electrical equipment. Dental or friction clutches. Air, oil or mechanically operated brakes and clutches.

SMALL SLUSHERS

Famous for low maintenance and long life. These rugged little slushers are available in 10 to 75 HP sizes. Ball and Roller Bearing construction, sealed planetary gearing, heat-dissipating clutches. Built to any required production in single, double or triple drum models.

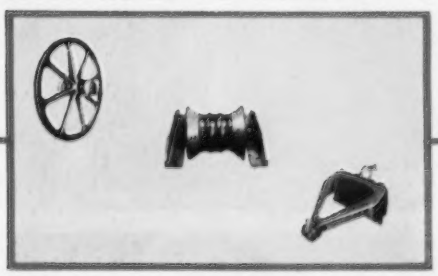
LARGE SLUSHERS

These 100 to 150 HP high capacity slushers are available in single or double drum models. Long used and continually reordered for large tonnage block caving operations. Wide choice in controls and features.

SKIPS and CAGES

Automatic bottom dumping skips are the coming thing. Vulcan vertical, self dumping skips or skip-cage combinations built to your requirements offer maximum strength and safety, high capacity-to-weight ratios. Vulcan cages are safe and easy running, available in various styles.

SHEAVES • ROLLERS • SCRAPERS



Ball and roller bearing sheave designs with cast steel or Mehanite construction. Grooves flame hardened or with replaceable liners. Low inertia designs for all hoisting service.

Try this slope roller with replaceable rubber segments for heavy service. Cushions rope for longer life. Segment rings also in Neoprene. Alemite lubricated sealed ball bearings.

One-piece scrapers of manganese steel with replaceable liner. Built to match the service of large Vulcan slushers.

AIR & ELEC. CHAIN SAWS

Widely used among larger underground mines. More than double the work capacity of ordinary chain saws. Built for long, trouble free service and easy handling.

WORLDWIDE SALES REPRESENTATION
through **DORR-OLIVER, INC.**, Stamford, Conn., and Associated Companies and Representatives

WRITE FOR LITERATURE AND QUOTATION TO YOUR SPECIFICATIONS

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1423 STOUT STREET
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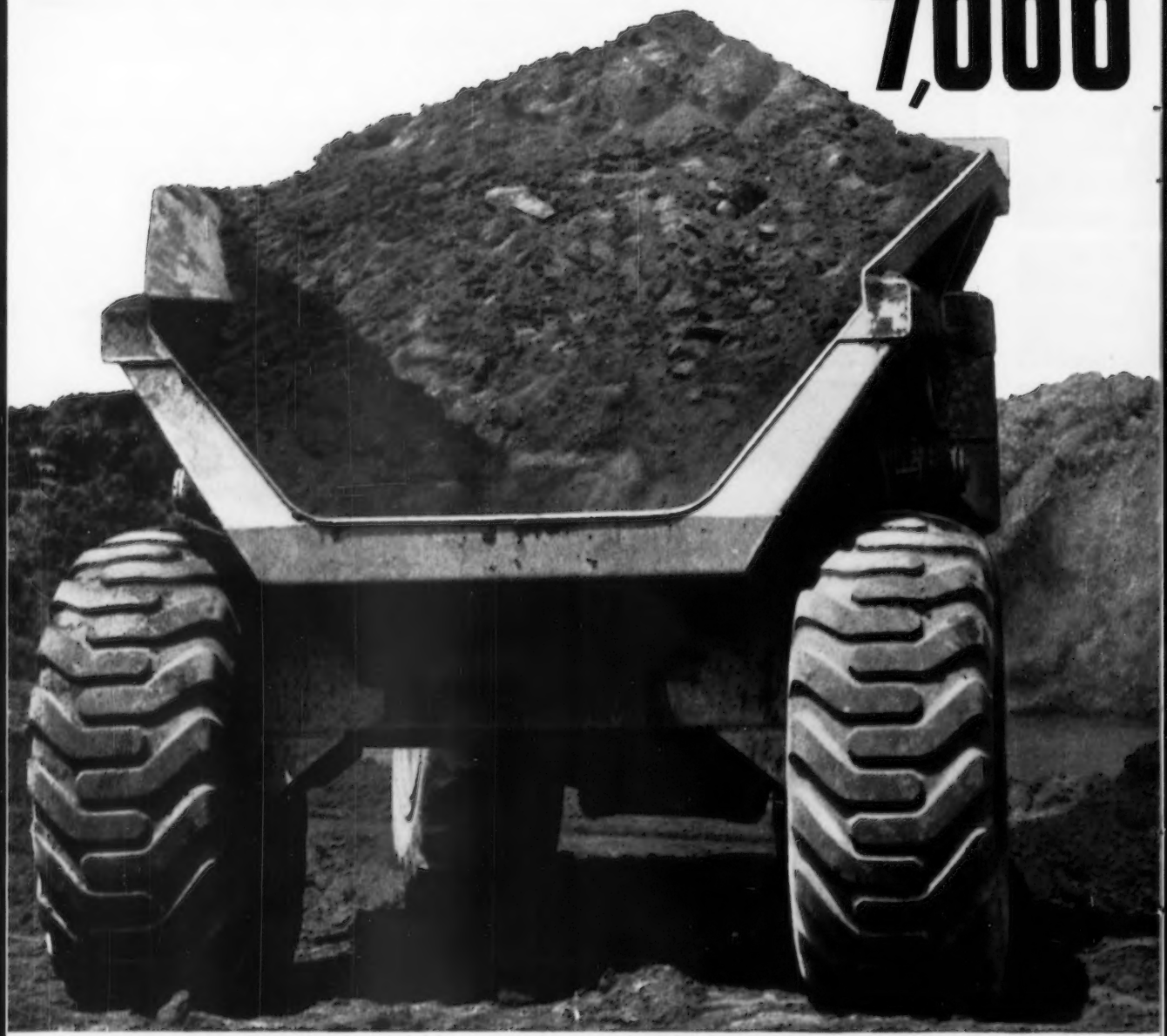
WORLD FAMOUS for QUALITY and SERVICE

8 YARDS OF PAYLOAD
7,000



WEIGHS 3½ TONS LESS

TRAVELS FASTER

CARRIES MORE PAYLOAD

ADDED! POUNDS SAVED!

High strength-to-weight ratio of USS "T-1" Steel solves difficult design problem

In the past, lightweight materials such as bauxite ore have presented a hauling problem *because* of their light weight. Standard hauling units, designed for heavier materials, had too much dead weight . . . couldn't haul enough volume of lightweight materials. Athey Products Corporation, Chicago, Illinois, has solved the problem with the help of USS "T-1" Steel.

Athey engineers designed a new rear-dump trailer specifically for high-volume lightweight materials. Starting point was a conventional 22.5-cu.-yd. trailer. The high yield strength of USS "T-1" Steel—90,000 psi minimum—enabled them to use much higher design stresses and, thus, reduce the thickness of steel required.

As a result, volumetric capacity of the 22½-cu.-yd. model was boosted to 30½ cu. yds. The new unit weighs just 13 tons—7,000 pounds less than it would if built with low-alloy steel. USS "T-1" Steel's toughness and resistance to impact abrasion give the trailer ruggedness and durability needed in off-road mountain service.

This lighter-weight trailer can travel much faster, when empty, than heavier standard units. As a result, it spends less non-productive time in making empty return trips to the mine. It not only carries more payload, but is hauling payload during more of its total operating time.

• • •

Where can you use USS "T-1" Steel?

Consider USS "T-1" Steel where you need an unusually high strength-to-weight ratio . . . where you need unusual toughness and resistance to impact abrasion at low temperatures . . . where you need good high-temperature strength. Remember, *all* of these properties are combined with weldability in USS "T-1" Steel. Call, wire or write for more information. United States Steel, Pittsburgh 30, Pennsylvania.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

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USS "T-1" CONSTRUCTIONAL ALLOY STEEL USS

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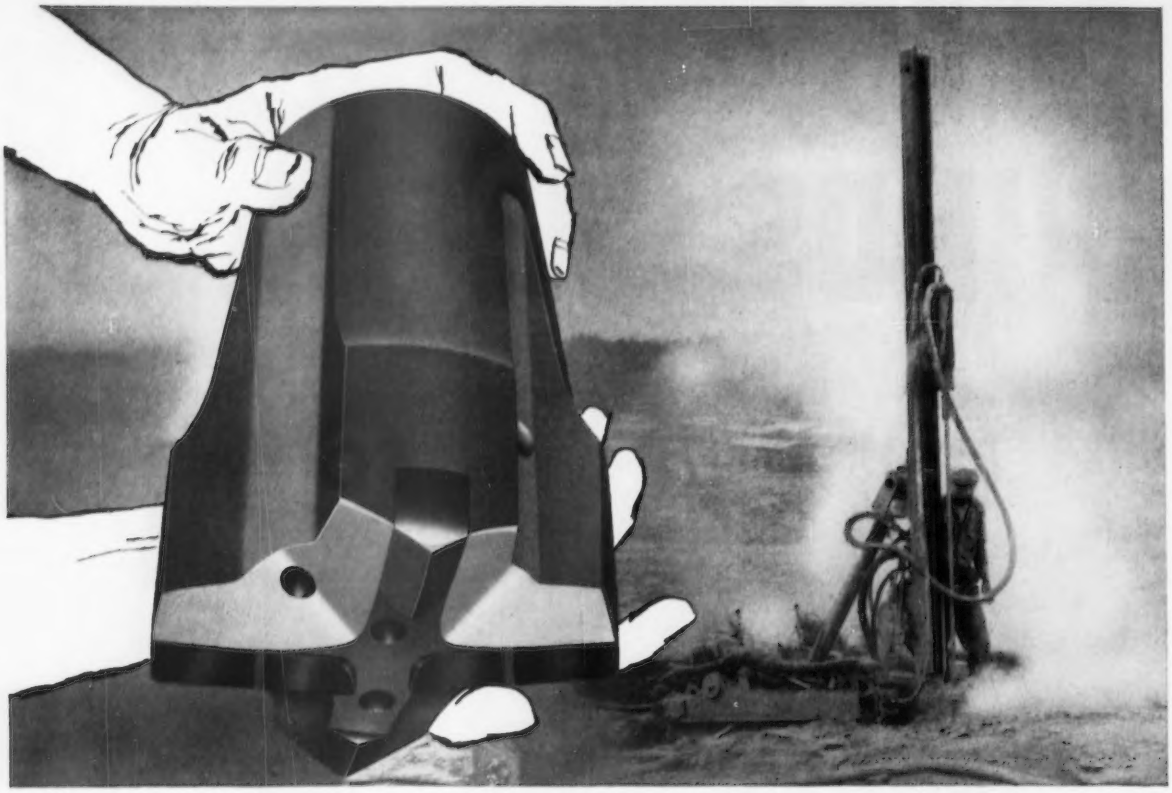
UNITED STATES STEEL



Kennametal Style PX Rock Bits are available in sizes from 2½″ to 5″ diameter. The one shown here is a 5″ size.

Here is what you get when you use the improved Kennametal* Style PX Rock Bits

Fast penetration . . . long service life . . . minimum maintenance . . . these are benefits you get when you use Kennametal *Style PX* Rock Bits.

The improved "X" design eliminates rifling, provides greater chip clearance and, thus, promotes faster penetration. Alternate long and short carbide insert design puts the carbide where it is needed most, and also speeds penetration. This design permits the use of two off center water ports to improve the removal of cuttings.

Longer bit life in service is provided by three new design features: First, these bits generally have more carbide than other bits of equal size. Second, the long inserts are segmented for greater strength. Third, all inserts are of special grades of carbide that were developed specifically for percussion drilling.

Another feature of this new design is the elimination of the center spacer which is a common source of trouble in drilling operations.

Why not investigate these bits for your drilling problems? A Kennametal representative will gladly help you select the size and grade of Kennametal Rock Bits for each of your operations. Call him or write KENNAMETAL INC., MINING TOOL DIVISION, Bedford, Pennsylvania.

TYPICAL PERFORMANCES

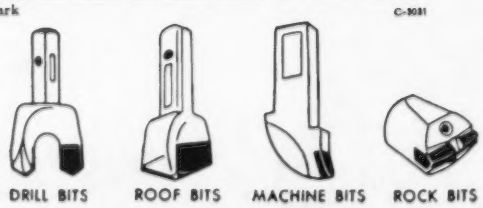
PX-600-3½ and PC-600-3 drilled 150 ft. per regrind (8-10 regrinds per bit) in abrasive Pocono sandstone at speeds of 12″ to 14″ per minute.

PXK-3½ drilled more than 1000 ft. per bit of hard diabase rock.

*Trademark

C-9031

INDUSTRY AND
KENNAMETAL
...Partners in Progress



DRILL BITS ROOF BITS MACHINE BITS ROCK BITS

OVER HALF CENTURY EXPERIENCE IN

Exploration and Development
Diamond Core Drilling
Rock Breaking • Grouting • Shaft Sinking
Mining • Quarrying and Tunnel Driving

Full details on request

Boyles Bros.
DRILLING COMPANY

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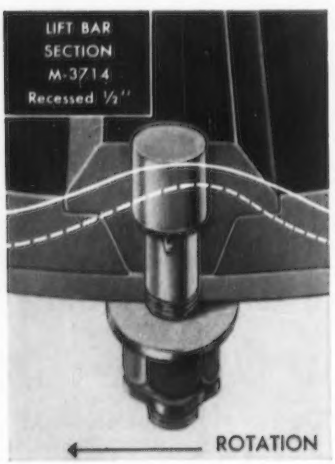
Leadville, Colorado	Telephone 443-W
Phoenix, Arizona	Telephone CRestwood 4-5331
Monticello, Utah	Telephone 93R1 and 91R4
Reno, Nevada	Telephone FAirview 9-0732
Denver, Colorado	Telephone WEst 4-0673
Alaska	Contact Salt Lake City Office

Four USS Lorain Rolled Plate Linings

better 4 ways...

This type of low-cost lining is recommended for cement and soft grinding jobs. Plates are available in 1¼" and 1½" thicknesses. Bars are 6" wide—with 1⅜" lift. Ideal with balls up to 1¼" diameter. Line indicates maximum wear pattern.

Plates are available in 1½", 2", 2½" and 3" thicknesses. Bars are 7" wide—2½" lift. Designed for use with larger diameter balls up to 4". Line indicates maximum wear pattern.



Plates are available in 2", 2½" and 3" thicknesses. Bars are 7" wide. With the ½"-deep plate recesses, lift is 2". Because of the recessed design, bearing surface is retained permitting replacement of lift bars for extended service. Solid line indicates wear pattern with original bars. Dotted line indicates wear line of replacement bars.

Heavy duty linings and lift bars for toughest grinding assignments. Plates are available in 2", 2½" and 3" thicknesses. Bars are 8⅜" wide. Variable lifts from 1⅛" to 2½" are available. Line indicates maximum wear pattern.

These four important features of USS Lorain Rolled Plate Linings mean peak grinding efficiency . . . no matter what the grinding assignment. Compare them with *any* other liners on the market.

1. These are the only linings made of *hot rolled* steel. Our bars and plates are not castings, but are special hot worked steel, given superior toughness that eliminates breakage even when worn to paper thinness.

2. Lift bars are of rolled alloy steel with extra hardness and toughness that provides lift and better grinding efficiency throughout the life of the lining. For more severe service, bars are heat treated.

3. Lift bars and lining plates are made to exact dimensions for close tolerances that permit snug fit and eliminate shell wash—no zincing required.

4. Better design, better materials – they permit the use of thinner linings, thus increasing mill capacity.

Call on us for expert technical assistance on any grinding problem.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

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USS LORAIN ROLLED PLATE LININGS and USS GRINDING BALLS

5-2477

UNITED STATES STEEL

ORDER OR SPECIFY SPRAGUE & HENWOOD "ORIENTED" DIAMOND BITS

LOWER COST-PER-FOOT

Sprague & Henwood, in close co-operation with the United States Bureau of Mines, initiated the practice of "Orienting" drilling diamonds in their diamond bits. It was believed that by "Orienting" drilling bortz in their hard vector direction, that the "cost-per-foot drilled" should be substantially reduced.

Sprague & Henwood's contract drilling department has used over 30,000 "Oriented" diamond bits, and has supplied customers with thousands more. Proof that Sprague & Henwood "Oriented" diamond bits reduces the "cost-per-foot drilled" is explained and outlined in detail in Bulletin #320-1.

All Sprague & Henwood diamond bits are designed to do a specific job, and with information concerning your particular problem, Engineers will suggest and supply you with the Bit, Reaming shells and all accessory equipment necessary to give you the most for your drilling dollar.

Sprague & Henwood has developed four different types of matrices to be used if formation ranging from very soft, to extremely hard or highly abrasive stratas.

When you need diamond bits . . . Call Sprague & Henwood in Scranton, the phone number to remember is DIamond 4-8507. You furnish the information on your conditions. They will supply you with the finest diamond drilling bits you can possibly buy anywhere.

IMPREGNATED CORING BIT
Especially suitable for drilling through hard, broken or extremely abrasive ground, where diamond loss from surface-set bits might be excessive. EX, AX, BX and NX sizes carried in stock. Larger sizes and special designs when required.

"ORIENTED" DIAMOND "TAPER" TYPE NON-CORING BIT
The fastest cutting bit for drilling blast holes in very hard formations. All standard sizes.

"ORIENTED" DIAMOND "PILOT" TYPE NON-CORING BIT
Recommended for drilling blast holes in hard formations and also for use when long straight holes must be drilled in variable formations.

"ORIENTED" DIAMOND "CONCAVE" TYPE NON-CORING BIT
Especially suitable for drilling round smooth holes in relatively soft formations, when cores are not required. All standard sizes available in four different types of matrix.

"ORIENTED" DIAMOND CASING-SHOE BIT
Available in the same wide range of sizes and types as the standard casing bits and designed so that they can be left on the end of the casing in the hole while drilling is continued through them with the corresponding standard size of core barrel and bit.

"ORIENTED" DIAMOND STANDARD CASING BIT
Available in all standard sizes with a choice of four different matrices and three different grades of selected diamonds. Larger sizes and special designs furnished as required. Must be removed before continuing to drill with core barrel and bit.

DOUBLE-TUBE REAMING SHELL
Available in all standard sizes for use with all types of double-tube core barrels. Special sizes and types as required. Inserts are tough tungsten-alloy matrix set with carefully selected diamonds.

"M" SERIES "ORIENTED" DIAMOND CORING BIT
For use with "M" SERIES Core Barrel, when good cores must be secured from soft or friable strata. Available in all four types of matrix and three different grades of diamonds. Also in a complete range of impregnated sizes. EX, AX, BX and NX sizes carried in stock.

"ORIENTED" DIAMOND CORING BIT
Available in four different matrices and three different grades of correctly-sized diamonds. EX, AX, BX and NX sizes carried in stock. Larger sizes and special designs furnished to meet any specifications or requirements.

SPECIFY SPRAGUE & HENWOOD FOR FAST... DEPENDABLE... RESETTING SERVICE

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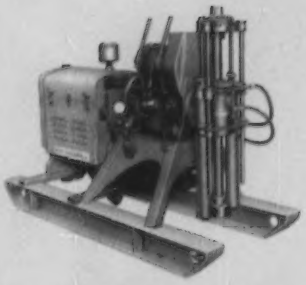
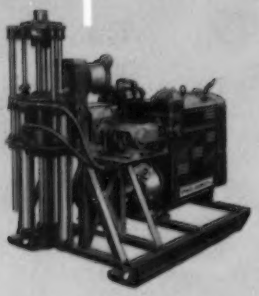
MODERN . . . DEPENDABLE . . .
HIGH SPEED DRILLING MACHINES
AND LATEST ACCESSORY EQUIPMENT

YOUR COMPLETE DIAMOND CORE DRILLING - CENTER -

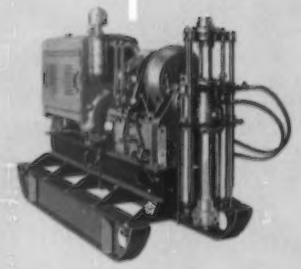


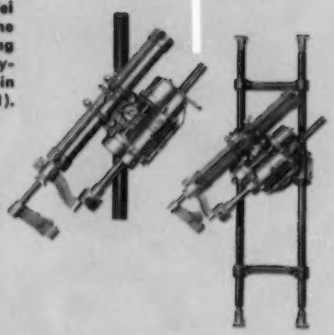
Sprague & Henwood Model 40-C Gasoline Engine Driven Core Drilling Machine, Low mount type, with double hydraulic swivelhead, oil operated with built-in circulating system. Bulletin # 185-1.



Sprague & Henwood Model 30 Water-Cooled Gasoline Engine Driven Core Drilling Machine with a double hydraulic swivelhead. Built-in water pump (optional). Bulletin # 350.

Sprague & Henwood Model 142 Gasoline Engine Driven Core Drilling Machine, with built-in oil circulating system and hydraulic swivelhead. Bulletin # 160





Model 325 and Model 550 Air operated machines for diamond core drilling underground. Driven by four cylinder radial-type air motors, both of these modern machines have ample capacity for fast steady operation.

ACCESSORY EQUIPMENT

A new and complete catalog No. 400 listing all accessory equipment is available. Write for your free copy today. It will be mailed promptly.

CONTRACT DIAMOND DRILLING...ANYWHERE

For over 70 years Sprague & Henwood has been the leader in the contract diamond drilling field. In that time, crews have completed thousands of contracts successfully, all over the world, in every conceivable condition.

For the best in exploratory core drilling (surface or underground), blast hole drilling, directional drilling, foundation test drilling, grout hole drilling, and pressure grouting—be sure to call Sprague & Henwood. Estimates and suggestions given without charge.

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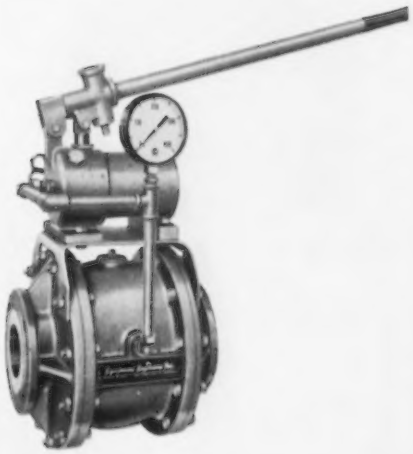
EE PRODUCTS DO THE JOB BETTER AT LOWER COST!

Model EE20-9
integral two stage

Krebs Cyclones

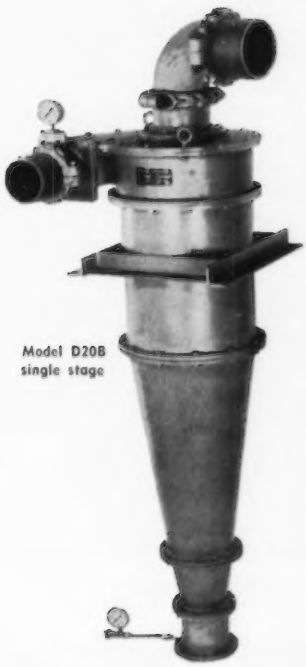
Longs sweep inlet for better performance and capacity at lower psi. Molded replaceable pure gum rubber parts throughout. Adjustable apex valves for all sizes.

EE PRODUCTS

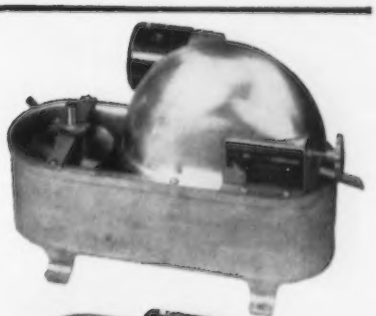


Krebs Valve

The round hole, center flow makes it the most efficient valve for heavy duty service. Knows no maintenance expense. Hydraulically operated—remote if desired. Write for performance curves showing quickly responsive control.



Model D20B
single stage



Model E in 18-8 stainless steel. Also available in duplex and triplex units.

Clarkson Reagent Feeders

The standard for precise and low cost feeding of reagents throughout the world. The Clarkson Company is a Division of EE Inc.

Model E in PVC for acids.

EQUIPMENT ENGINEERS INC.

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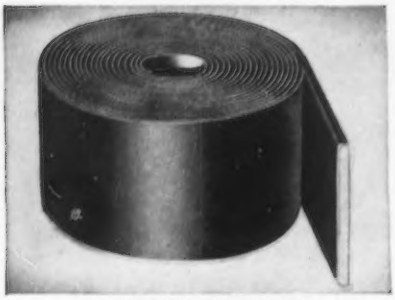
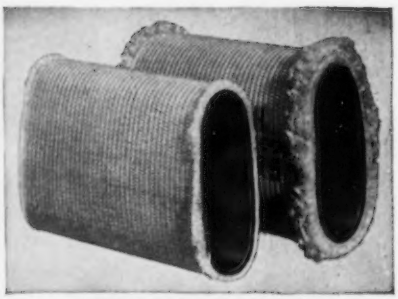
Bulk Materials Handling Systems



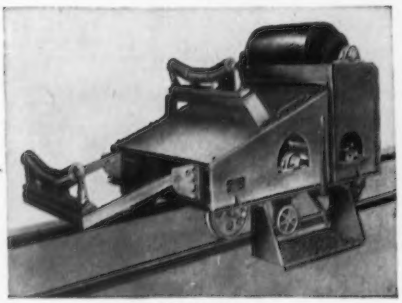
CONVEYOR BELTING

ELEVATOR BELTING



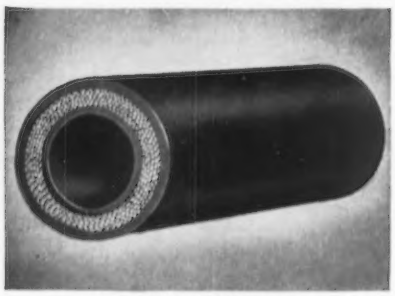
MONARCH FIRE HOSE

ENGINEERED CONVEYORS

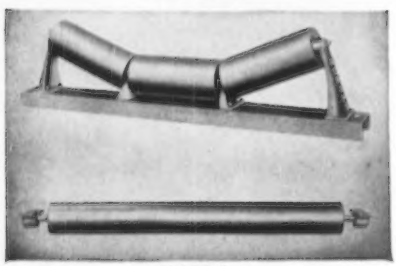


TRIPPERS

CAR SHAKEOUTS



AIR HOSE



IDLERS

HEWITT-ROBINS MACHINERY PRODUCTS. A complete line of specialized machinery for conveying, screening, sizing, elevating, distributing, blending, and storing loose bulk materials of every description.

HEWITT-ROBINS RUBBER PRODUCTS. A wide range of rubber conveyor belts, transmission belts, industrial rubber hoses, and molded rubber products.

HEWITT-ROBINS ENGINEERING SERVICE. Our engineers' vast experience qualifies them to solve almost any bulk materials handling and processing problem which might arise.

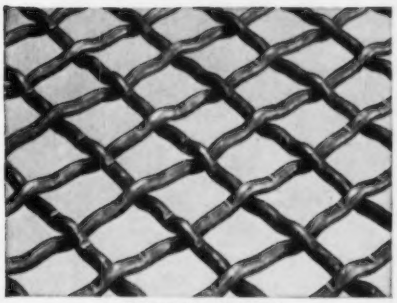
By dealing with Hewitt-Robins you'll save time and trouble . . . our products and services will furnish you with better integrated bulk materials handling systems and better designed and constructed processing equipment to solve your particular problem.

HR HEWITT-ROBINS

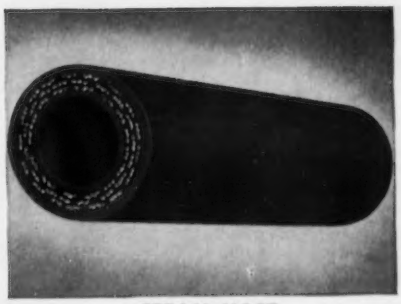
STAMFORD, CONNECTICUT

THE NAME THAT MEANS EVERYTHING IN BULK MATERIALS HANDLING SYSTEMS...

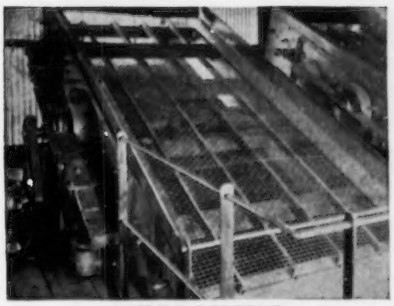
and Equipment for Industry



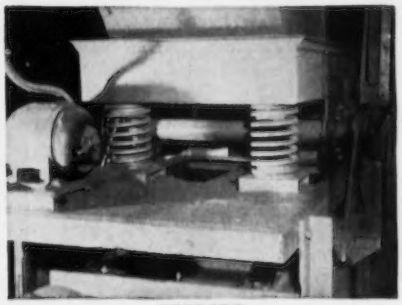
SCREEN CLOTH



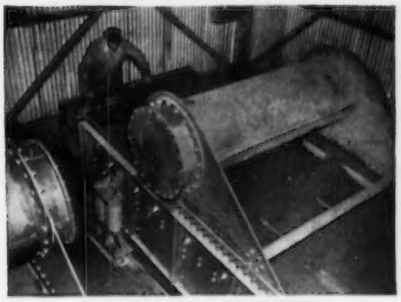
STEAM HOSE



GYREX SCREENS



FEEDERS



ELIPTEX DEWATERIZER

PINCH VALVE HOSE

STACKERS

SECTIONAL CONVEYORS

Here is a partial list of HEWITT-ROBINS PRODUCTS that will help you cut handling costs and increase operating efficiency.

MACHINERY

Belt Conveyors
Belt & Bucket Elevators
Car Shakeouts
Conveyor Idlers
Dewaterizers
Mechanical Feeders
Mine Conveyors
Reclaiming Systems
Screen Cloth
Self-Unloading Boats
Ship Loading & Unloading Systems
Stackers & Trippers
Vibrating Conveyors & Screens
RoBINtronic® Bin Level Indicators

INDUSTRIAL RUBBER PRODUCTS

Belting:

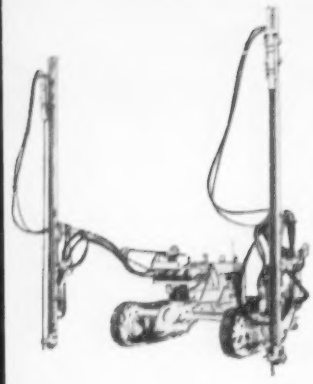
Chute and Launder Lining
Conveyor
Elevator
Skirtboard Rubber
Transmission

Hose:

Acid
Air & Air Drill
Dredge Sleeves
Fire
Flexible Rubber Pipe
Fuel Oil & Gasoline
Gasoline Pump
Oil Suction & Discharge
Pinch Valve
Road Builders'
Sand Suction
Sea Loading
Servall®, All-Service
Steam
Vacuum & Air Brake
Water & Water Suction
Welding, Twin-Weld®

A-3202-X

INDUSTRIAL HOSE • VIBRATING CONVEYORS, SCREENS & SHAKEOUTS
CONVEYOR BELTING & IDLERS • POWER TRANSMISSION DRIVES



T-286 dual drill rig. Useful 25 hp tractor mounting two heavy-duty air-motor powered drill booms. Goes anywhere under its own power.

A complete line of sinkers from 17 to 80 lbs., featuring the new shock-absorbing design that has 55% less kick than other drills, but the same bit impact.

One-use detachable non-threaded bits for sinkers, drifters, and stopers. Special offset-gauge feature reduces binding and provides extra clearance for cutting so that drilling speeds are faster. Simple taper fit.

New Air-Leg design — way out in front of all others. Can be used as a stoper, drifter, or sinker. 3', 4', 5', and 6' feed legs — conventional or telescopic. Fine control, easily handled.

LE ROI NEWMATIC ROCK DRILLS

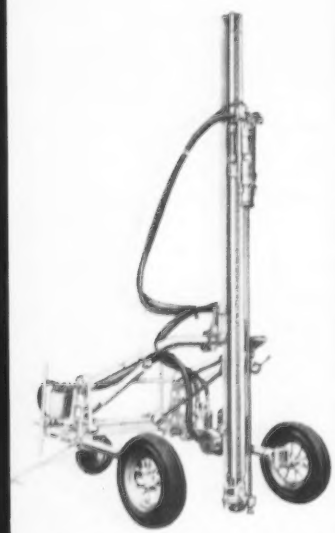
— a complete line of equipment for all types of mining!

Le Roi rock-drills are *designed* for mining — built to endure tough service and stay underground on the job. The Le Roi line includes a size and type of tool for every mining operation, including many not illustrated, such as mine jumbos, power-feed drifters, and others.

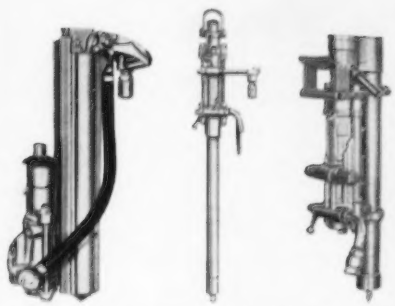
Operators like them because they are easy to run — owners love 'em because they stay at the face, not in the shop.

This all adds up to more feet of hole drilled per shift, increased man-shift production, and lower costs.

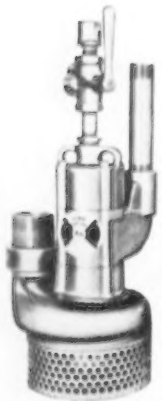
Try Le Roi rock drills — there's one just right for *your* job! For additional information, write us. We'll gladly send specifications and data.



Heavy-duty DR40 feed shells with D14R drifter for deep drilling in extra hard ground.



Stopers for every need, featuring Vac-Nu-Matic dust collection and the Sav-A-Change chuck. Improved design means easier drilling. Conventional or telescopic feeds.



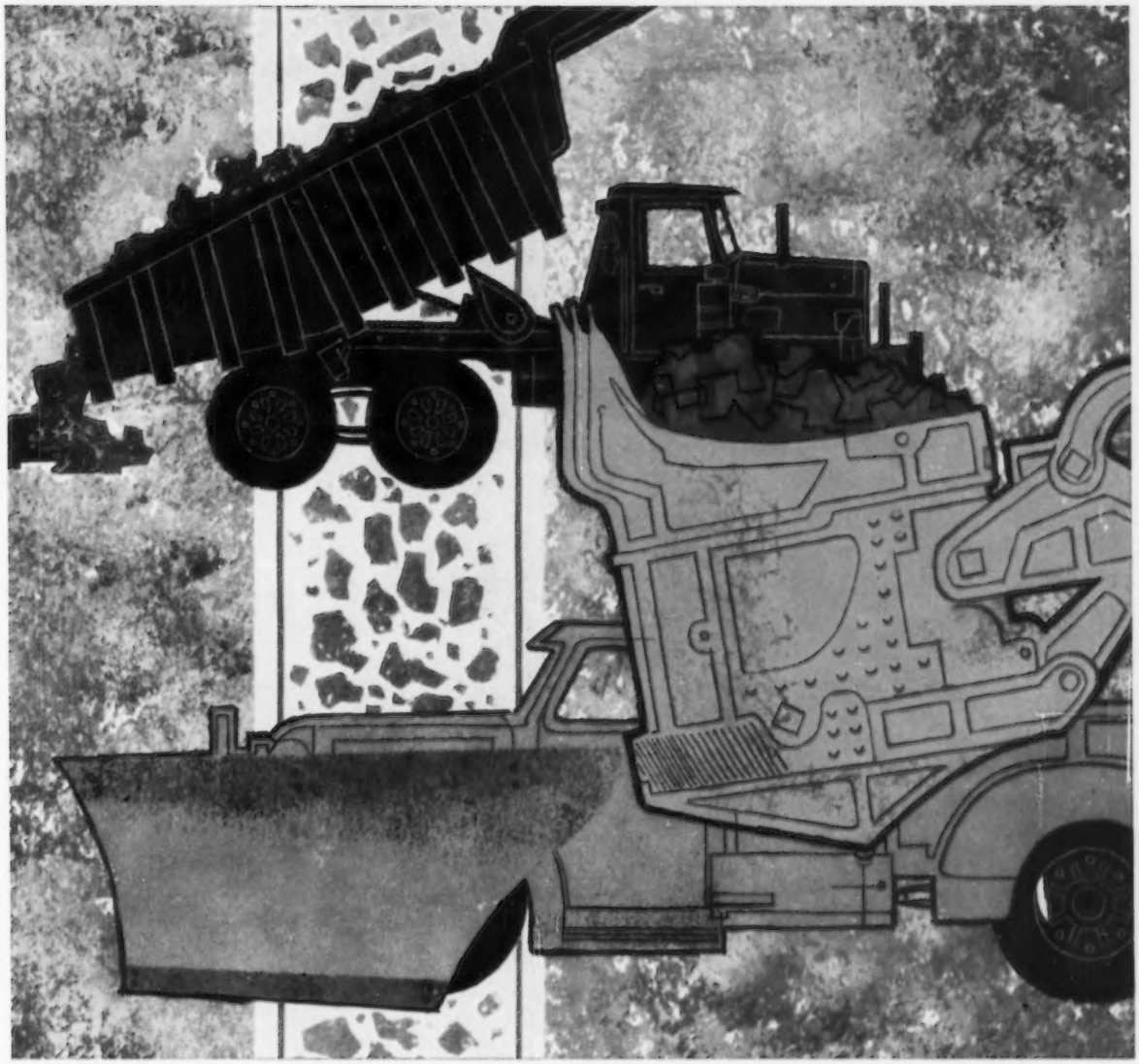
Easy-handling, no-prime, air-operated sump pump for fast, efficient water removal, easy transportability. Capacities to 340 gpm, heads to 70 ft.

Le Roi shaft sinking Jumbo. 4 or 6 drills, all air-motor powered. Sinks shafts up to 28 ft. in diameter. For fast shaft-sinking.

LE ROI

Division of Westinghouse Air Brake Co., Milwaukee 1, Wisconsin, manufacturers of air tools, Tractair®, portable and stationary air compressors, and heavy-duty industrial engines. Write us for information on any of these products.

AT-85



JALLOY special alloy steel

resists impact and abrasion in toughest applications

Heat treated Jalloy steels wear as much as 20 times longer than mild steels under rigorous impact and abrasive conditions. By using Jalloy you can cut maintenance costs drastically. Increased product life reduces downtime and lowers your labor costs.

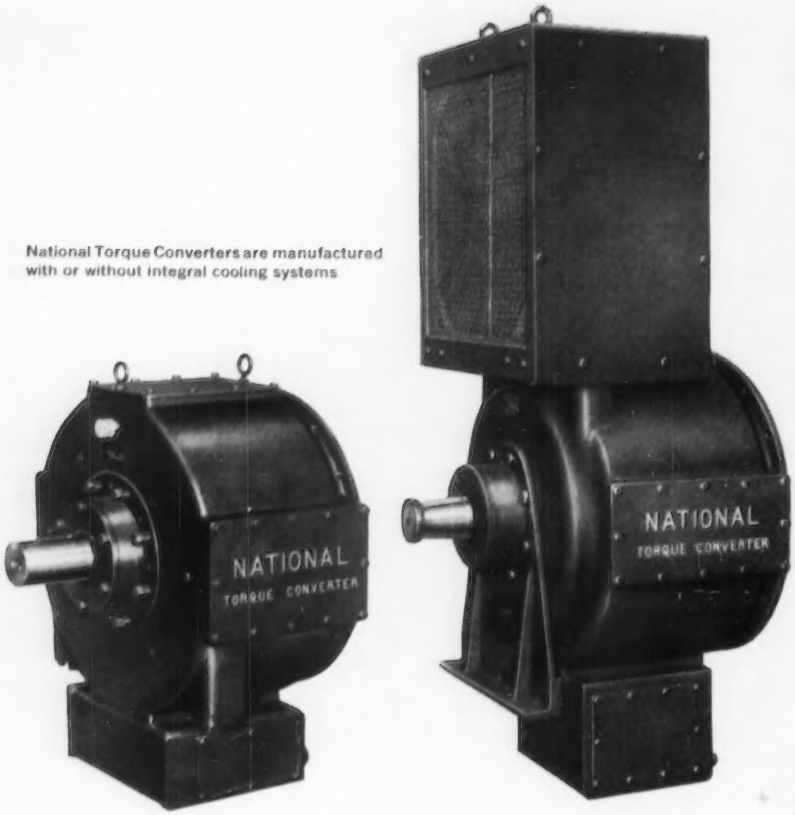
Jalloy steels are available in the forms you require (plates, hot rolled sheets, hot rolled bars, small shapes and structurals). Jalloy can be purchased in three grades to meet specific use requirements: Grade 1, where formability is important; Grade 3, capable of being heat treated to excellent physical properties for good resistance to abrasion or wear; Grade 7, where high hardness with good ductility or wear resistance is desirable.

Your local distributor can supply you with latest information on these Jalloy grades, or you can write to Jones & Laughlin Steel Corporation, Dept. 412, 3 Gateway Center, Pittsburgh 30, Pa.

J&L STEEL

Jones & Laughlin
... a great name in steel

National Torque Converters are manufactured with or without integral cooling systems



Plan now to DESIGN with National Torque Converters

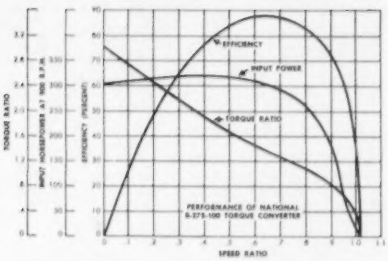
The simplicity of design of National Single-Stage Torque Converters permits exact matching of torque converter to prime movers of 100 to 1000 horsepower. Installation is simple and easy on stationary as well as mobile equipment. When matched to your prime mover, the National Torque Converter assures uniform top performance on every job. It will give your equipment a constant flow of smooth, steady power over a wide range of loads. It permits quicker starting and faster acceleration of loads, with no lugging or stalling of the prime mover. The torque converter absorbs the shock of sudden overloads, permitting the prime mover to operate at all times at governed or optimum speed.

Our engineers will gladly discuss the application of National Torque Converters to your equipment and help you select exact size and torque capacity. Why not call on them? Or write for Bulletin No. 468.

Consider these National Torque Converter features

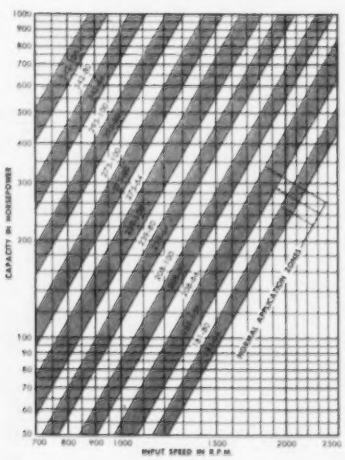
- SIMPLICITY OF DESIGN for ease of installation, operation and maintenance
- FULL RANGE OF CIRCUIT SIZES permits exact matching to prime movers of 100 to 1000 horsepower
- TOP PERFORMANCE enables engine or motor to operate at its optimum speed . . . deliver maximum horsepower constantly
- REPRODUCIBLE EFFICIENCY assures uniform top performance on every job
- FASTER JOB CYCLES means more loads per equipment per operator per day
- UNSURPASSED DURABILITY provides longer service life with minimum maintenance

Typical performance curves



Curve shows torque-speed ratio for series B-275-100 National Torque Converter. Performance Curves of all six sizes and 17 hydraulic circuits covering the 100 to 1000 horsepower range are available on request.

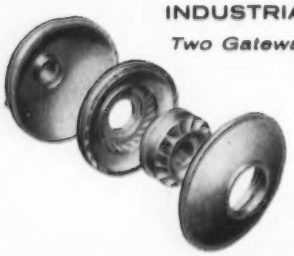
National Torque Converter Capacity Chart



THE NATIONAL SUPPLY COMPANY

INDUSTRIAL PRODUCTS DIVISION

Two Gateway Center, Pittsburgh 22, Pa.

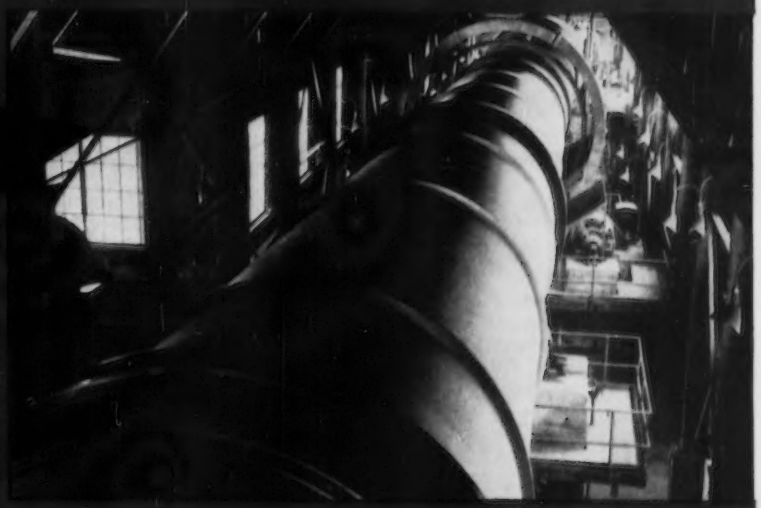


Pace-setters in the progress of industrial power transmission

SMIDTH

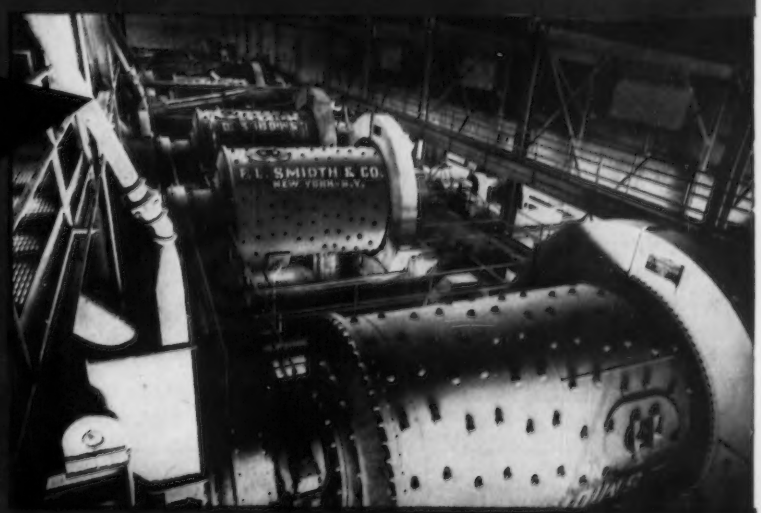
Rotary Kilns

For sintering, nodulizing, calcining, desulphurizing, oxidizing and reducing roasting—coolers, precoolers, preheaters, recuperators—and auxiliary equipment.



Grinding Mills

Ball mills, tube mills and multicompartment mills—open or closed circuit—wet or dry grinding also airswept for grinding and drying.



Over 1,000 Smidth Rotary Kilns and over 5,000 Grinding Mills supplied all over the world.

F. L. Smidth & Co.
Engineers and Machinery Manufacturers
11 West 42nd Street
New York 36, N. Y.

F. L. Smidth & Co., A/S
77 Vigerslev Alle
Copenhagen, Denmark

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105, Piccadilly,
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F. L. Smidth & Cie France
80 Rue Taitbout
Paris (9e) France

F. L. Smidth & Co. of Canada, Ltd.
11 West 42nd Street
New York 36, N. Y.

F. L. Smidth & Co. (Bombay) Private Ltd.
42 Queen's Road
Bombay, India

FOR MANUAL APPLICATION

THIS HARD-FACING ROD	FOR THESE CONDITIONS	FOR THIS EQUIPMENT	APPLI-CATION
VICTORTUBE	Severe abrasion	Ripper and ditcher teeth, dredge cutter blades, posthole augers, oil field tools, pug mill knives	ACETY. AC-DC ELEC.
VICTORTUBE BARE-30-DOWN	Severe abrasion	Agricultural tools	ACETY. ONLY
VICTORTUBE "SPECIAL"	Abrasion, severe impact	Oil field bits, rock bits	ACETY. ONLY
VICTOR TUNGSMOOTH	Thin cutting	Augers, bits, blades, screw conveyors, farm tools	ACETY. AC-DC ELEC.
VICTORITE	Earth abrasion, sliding friction	Farm tools, earthmoving rigs	ACETY. AC-DC ELEC.
TUBE VICTORITE	Abrasion, impact	Plow points and farm tools	ACETY. AC-DC ELEC.
VICTORITE 1	Corrosion, heat, abrasion	Chemical and food machinery, arbors, screw conveyors, soaking pit tongs	ACETY. AC-DC ELEC.
VICTORITE 6	Red heat, impact corrosion, abrasion	Forming dies, exhaust valves, cams, steam valves	ACETY. AC-DC ELEC.
VICTORITE 12	Heat, abrasion, impact	Saw blade inserts and other critical applications	ACETY. AC-DC ELEC.
VICTORITE CARBON ARC	High abrasion, thin deposit	Plowshares, lister shares, sweeps	CARB. ARC ACETY.
VICTORALLOY	Abrasion, severe impact	Crushers, dredge pumps and cutters, dipper teeth, tampers, rollers, idlers	ACETY. AC-DC ELEC.
VICTORALLOY #1	High abrasion, medium impact	Bucket lips, rock crushers, muller tires, gyratories	ACETY. AC-DC ELEC.
VICTORALLOY "A"	Angular shock, extreme impact, build-up	Clutch parts, gears, crusher plates, gyratory mantles, build-up for hardfacing	AC-DC ELEC. ONLY
VICTORALLOY "B"	Heavy impact, moderate abrasion	Tractor rollers and sprockets, shovel pads, plates, idlers, etc.	AC-DC ELEC. ONLY
VICTORALLOY "C"	High abrasion, moderate shock and impact	Tractor grousers, pressure rolls, crusher segments, roll crusher teeth	AC-DC ELEC. ONLY
VICTOR MULTI-PASS	Impact, compression, build-up	Drive sprockets and tumblers, rollers, idlers, churn drills, clutch jaws	AC-DC ELEC.

What's proper Victor rod for your hardfacing needs?

THIS CHART GIVES YOU QUICK ANSWER

Use it to select right rods for prolonging operating life of your equipment. You'll be selecting rods that go on quickly and smoothly, thereby saving labor and downtime. Order from your Victor dealer TODAY.

FREE—For more detailed information on how to apply Victor hardfacing alloys to wearing parts, write us NOW for your copy of Victor Hardfacing Manual. It's free.

VICTOR

for hardfacing

Profitable dealerships open; inquire now!

VICTOR EQUIPMENT COMPANY • *Alloy Rod & Metal Division*

13808 E. Imperial Highway, Norwalk, California . . . . . Wakita, Oklahoma

FOR AUTOMATIC & SEMI-AUTOMATIC APPLICATION

THIS TYPE	FOR THESE CONDITIONS	ON THIS KIND OF EQUIPMENT
#0	High abrasion, medium impact	Crusher rolls, rock crushing equipment
VA #1	Abrasion, medium impact	Crushers, scraper blades
VA #2	Abrasion, impact, Multi-pass application	Steel mill applications, tractor idlers
VA #3	Abrasion, light impact	Mill guides, crushers, dredge bushings
VA #4	Multiple layer build-up	Tractor rollers and idlers, sheave wheels
VA #5	Heavy impact, abrasion	Tractor rollers, idlers, mine car wheels, sheave wheels
VA #6	Medium abrasion, high impact	Crane wheels, drums, roll necks
VA #7	Abrasion, high impact	Build-up for hardfacing, mine car wheels
VA #8	Abrasion, high impact	Roll crushers, scraper and grader blades, tool joints
VT #60	Extreme abrasion	Tool joints, grader blades, scraper blades
Mo-Mn	Manganese build-up	Wherever manganese build-up needed

dig modern . . . cut tonnage costs with

P&H ELECTRIC SHOVELS featuring MAGNETORQUE* and ELECTRONIC CONTROL

In mining operations throughout the world there is good reason for the cost-cutting record of P&H Electric Shovels. Magnetorque plus P&H Electronic Controls give smooth, effortless operation—faster dipper action—heavier bail pull.

P&H Electric Shovels offer many other advantages that mean greater availability and lower maintenance costs, especially under severe conditions. With P&H you get all-welded strength, simplicity of design and proved on-the-job dependability. P&H Electric Shovels range from 3½ to 8 cu. yds. in capacity.

Customer demand for P&H equipment makes it wise to anticipate your *future* needs *today.* It will pay you to contact your P&H dealer soon.

*T.M. of Harnischfeger Corporation for electro-magnetic type coupling.

HARNISCHFEGER
Construction & Mining Division
Milwaukee 46, Wisconsin

3 ways to cut mining cable costs...

1. USE OKOCORD STANDARD CONSTRUCTIONS

Each Okocord construction has been designed to cut cable replacements on specific mining machines. Standard constructions for most of the important services are built from the conductor out to insure long life in the face of continual high speed reeling, rock-falls, frequent run-overs and constant dragging over mine floors and around corners. Here are four Okocord standard constructions.

Single Conductor—Reel cable made extra flexible and tough, Hex-Tite assembly to withstand re-reeling, rubbing and scraping.

Two-Conductor Round, Type G—Cable with two ground wires and two insulated conductors possesses maximum flexibility.

Three-Conductor Type W—Cable with three insulated conductors is available with heat-resistant insulations for either low or high voltages.

Twin Type G—Cable designed for maximum safety and reel capacity has center grounding wire and two insulated conductors.

2. USE OKONITE SPECIAL CONSTRUCTIONS

When you need a cable with unique specifications, consult with Okonite and avoid the costly troubles that often result from makeshift solutions. Special constructions are available for the newest mining equipment, including all types of continuous miners. Here are examples of the many Okocord special constructions that are manufactured to the same rigid specifications as standard constructions.

Three Conductor-Type PG—Special cable for d-c systems has uninsulated grounding wire which is approximately half the size of the two insulated conductors.

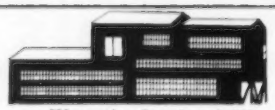
Four-Conductor Type PG—Special cable for d-c systems is similar to three-conductor type except with 3 insulated conductors.

Five-Conductor Type PCG—Special cable for "permissible" equipment features 1 uninsulated grounding, 2 insulated control and 2 insulated power conductors.

Six-Conductor Type PCG—Special cable for a-c systems is similar to five-conductor type except with 3 insulated conductors.

3. CONSULT WITH OKONITE ENGINEERS

The Okonite engineering staff is always ready to help you in the planning stage. Plant or mine power distribution, borehole or shaft cables, control systems, telephone circuits, conveyor controls . . . whatever your needs, Okonite will gladly help you select the safest and most economical cable for the job. Write or phone either our nearest district office or The Okonite Company, Dept. EM, Passaic, N. J.



. . . Watertite-Insulated Wire, Keystone-Insulated Wire, Okocord Flexible Cords, Watertite-Insulated Control Cable, Aerial Cable, Line Wire . . .

. . . Okocord Portable Cables Types W, G, SH-A, SH-B, SH-C, SH-D . . . Blasting Wire, Redshot Type RG, Type D Braided . . .

. . . Okocord Mine Drill and Control Cord, Okocord Type SO, Parkway, Okonite Mine Power Cable, Okocord Twin Type W . . .

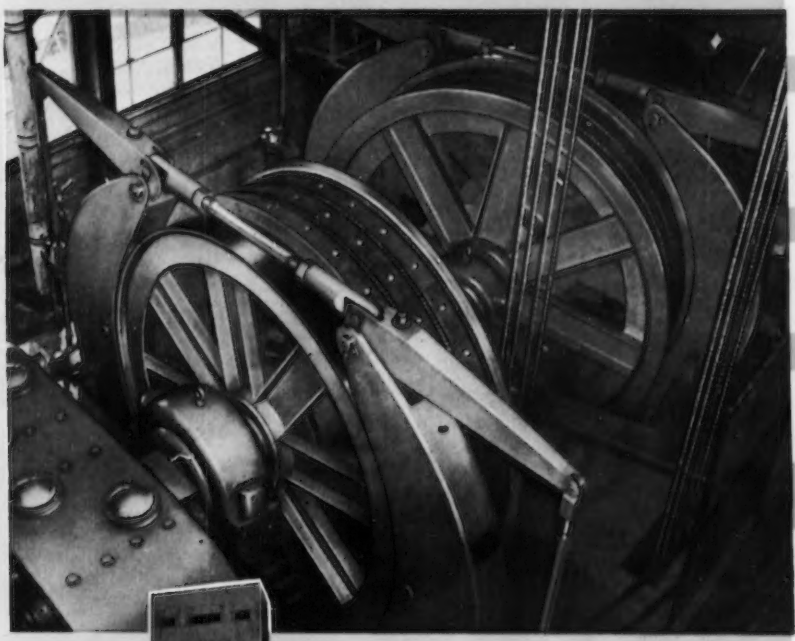
. . . Continuous Mining Cable, Okocord Two-, Three-, Four-, Five-, and Six-Conductor Types G, W, PG, and PCG . . . Steel Armored, Self-Supporting . . .

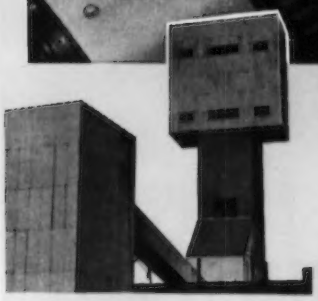
where there's electrical power . . . there's **OKONITE CABLE**

4184-A

FIRST MULTI-ROPE FRICTION HOISTS

IN U. S. BRING MAJOR SAVINGS IN INSTALLATION AND OPERATING COSTS





The tower-mounted ASEA multi-rope friction-drive hoists pictured here were installed by Cleveland Cliffs Iron Ore Company in the Cliffs Shaft Mine, Ishpeming, Mich. The installation consists of two ore hoists and one service hoist mounted in one head frame. The skip load is 15 tons, maximum speed 2000 ft/min; maximum depth 4000 feet; pushbutton controls.

Pioneering in the design and development of multi-rope friction-drive hoists, ASEA offers the advantage of its engineering background and wide experience in this new concept in mine hoisting. 14 ASEA mine hoists are on order for the U. S. and Canada—7 now operating.

Outstanding advantages of ASEA friction drive mine hoists

SAFETY

1. Several parallel ropes are used instead of a single rope.
2. Safety wedges on shaft guides assure rope slip and prevent overwind.

ROPE WEAR

1. Less wear due to elimination of fleet angle, absence of S-bends, and elimination of cross-overs in multilayer practice.

GUIDE WEAR

1. Less wear because ropes are arranged L.H. and R.H. lay so as to counteract any tendency of the conveyance to twist.

SIZE AND COST OF HOISTING UNIT

1. Smaller diameter and narrow width of pulley give low unit weights and reduced inertia.
2. Compact size and low weight permits installation in headframe above shaft with gravity flow through ore preparation plant.
3. Above factors result in lower initial capital and operating cost.

POWER DEMANDS AND CONSUMPTION

1. These are lower—due to balancing weight of tail rope and the decreased inertia of rotating parts.
2. Peak demands of individual conveyances in multilevel operation can be offset automatically by electric control.

FLEXIBILITY

1. Friction drive pulley can be used as a single drum, single rope hoist for initial shaft sinking.
2. Independent operation of single hoists with counterweights permits hoisting from different levels concurrently.

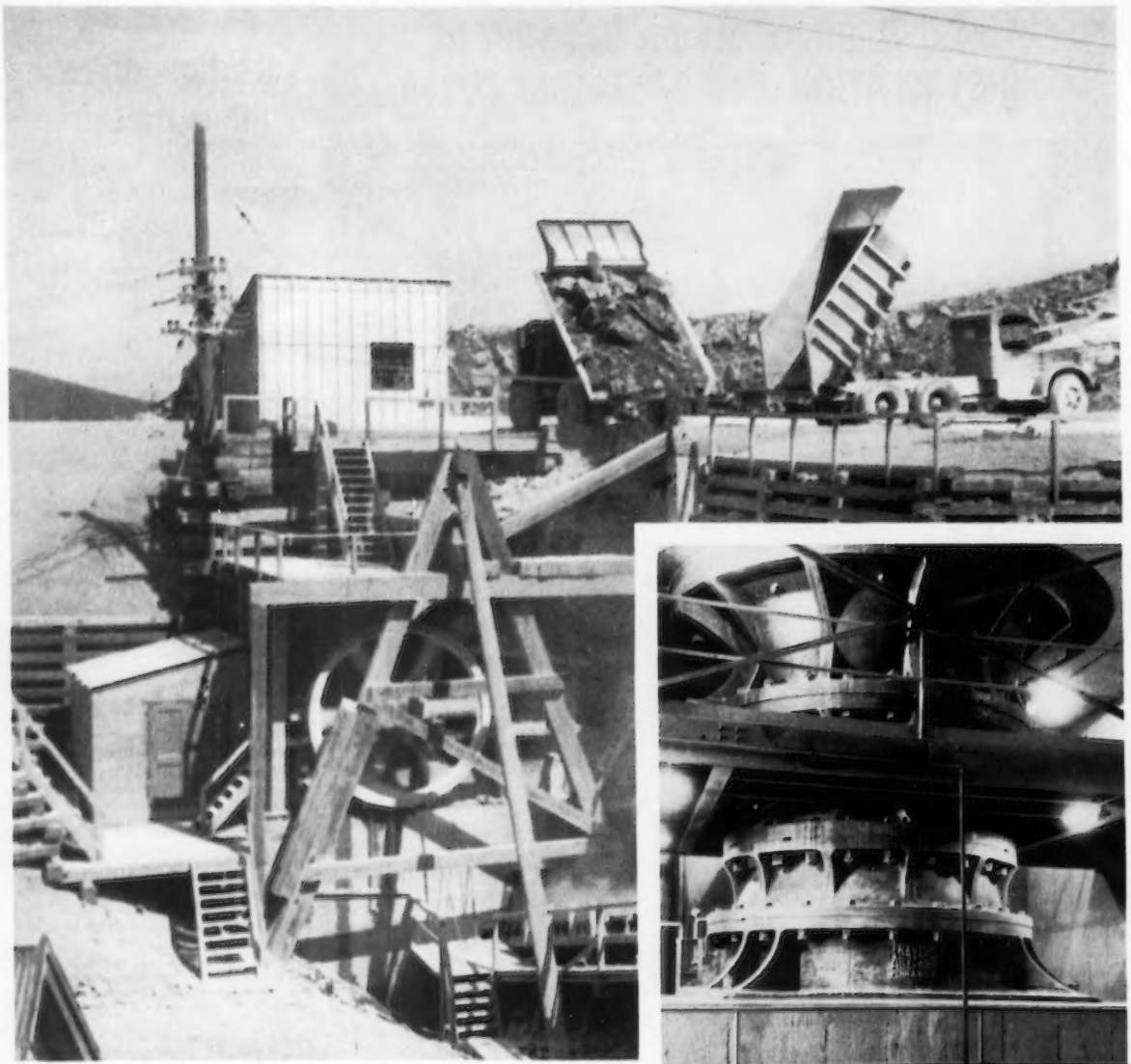
Illustrated booklets on ASEA mine hoists are available upon request.

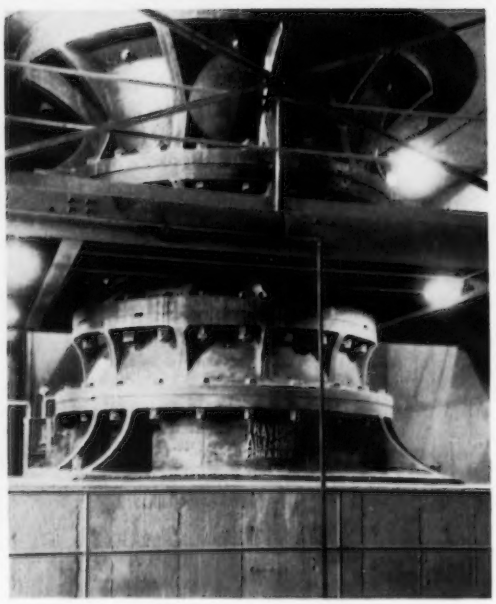
ASEA equipment is sold and serviced in the U. S. by:

AROS ELECTRIC, INC.

500 FIFTH AVENUE, NEW YORK 36, N. Y.

Where Profits are





TRAYLOR JAW CRUSHERS are built in 5 types with feed openings from 8" x 12" to 60" x 84". Product sizes range from ⅛" to 11"; capacities up to 1,000 tons per hour. Traylor curved jaw plates apply power more efficiently. The result . . . reduced power requirements per ton produced . . . less time lost due to packing and choking. Over the past 10 years, more than 125 Traylor Jaw Crushers have been built for service in the mining industries.

MORE COMPLETE INFORMATION is available in individual bulletins on the different types of Traylor equipment. Simply outline your requirements in a letter to Traylor Engineers. Bulletins on the appropriate Traylor Machinery will be sent to you.

TRAYLOR GYRATORY CRUSHERS are available in 3 types. Traylor TY Reduction Crushers and TF Fine Reduction Crushers are built in 6 sizes; capacities range from 6 tons of ¼" product to 590 tons of 3½" product per hour. Traylor TC Gyratory Crushers are built in 6 sizes; capacities range from 345 tons of 2" product to 4,100 tons of 11" product per hour. Traylor Gyratories feature bronze-bushed eccentrics, roller-bearing mounted countershafts and closed circuit, force fed lubricating systems . . . Traylor features that contribute to trouble-free, uninterrupted production over long periods of heavy-duty service. More than 94 Traylor Gyratory Crushers have been built during the last 10 years for profit-minded operators throughout the world.

measured by the Ton

the record shows it pays to put

Traylor-Made Machines on the Job

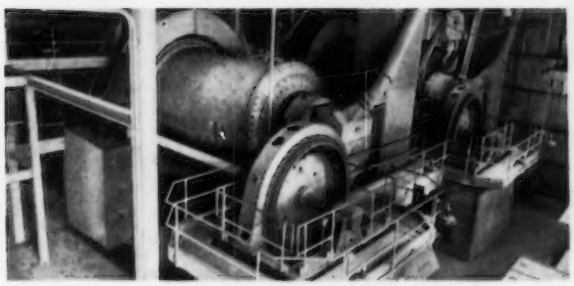
More than 373 Traylor Machines have been built for the mining industry during the past 10 years. That's an impressive record testifying to the outstanding performance of Traylor-Made Equipment. Wherever uninterrupted volume production plays an important part in profitable operations, many of the world's leading producers put Traylor Machines on the job.

All Traylor-Made Machines have the same basic characteristics. They are ruggedly built, of the finest materials, to withstand the steady pounding of heavy-duty service on 'round-the-clock production schedules.

All Traylor equipment reflects the experience accumulated by Traylor in serving the mining industry for over 50 years. The design principles of Traylor machines, proven in the field, have long been the acknowledged standards of the industry. Every Traylor Machine is custom engineered to the individual installation.

It will pay you to put a Traylor-Made Machine on the job wherever peak efficiency will up your production profits.

TRAYLOR ENGINEERING & MFG. CO.
961 MILL ST., ALLENTOWN, PA.
SALES OFFICES: New York • Chicago • San Francisco
CANADIAN MFRS.: Canadian Vickers, Ltd., Montreal, P. Q.



TRAYLOR GRINDING MILLS are available in sizes to meet practically every need. They are Traylor-Made in a variety of types including Ball, Rod, Compartment and Tube and Pebble Mills. Custom engineered to their job, Traylor Mills provide an extra degree of efficiency that results in extra profits on all grinding operations. More than 34 Traylor Mills have been built for the mining industry since 1947, ranging in sizes up to 1,500 H.P.

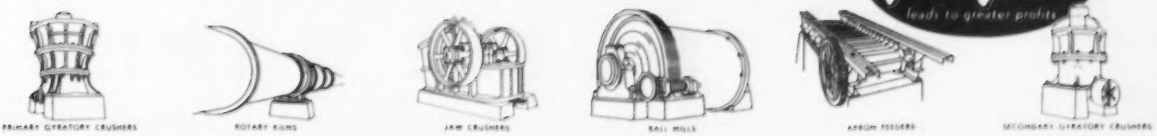
TRAYLOR ROTARY KILNS are widely used for calcining, roasting and chloridizing, volatilizing, sintering and nodulizing. They have been built in sizes up to 12' in diameter and 450' in length. More than 53 Traylor Kilns have been built during the past decade for leading producers throughout the world . . . producers who today are realizing the added production and profits that result from having a kiln Traylor-Made to their individual requirements.

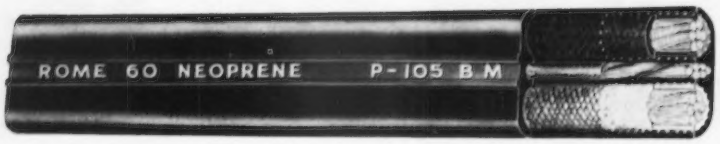
the experts agree . . . there's nothing like

TRAYLOR-MADE

equipment for peak performance

A Traylor leads to greater profits



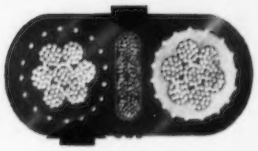


Parallel Duplex (Flat Twin) Mining Machine Cable—600 Volts
(Ungrounded or grounded)

Single-Conductor Locomotive Gathering Cable—600 Volts

Portable Power Cables—Two, Three and Four Conductors
(Ungrounded up to 3,000 Volts, or grounded up to 5,000 Volts)

Three-Conductor Mine Power Feeder Cable
(Shielded with ground wires up to 10,000 Volts)



Rome's shuttle car cable can't be damaged by bending

The rugged Neoprene jacket forms a resilient web between insulated power conductors and ground conductor for maximum impact resistance. The open braid on each conductor firmly interlocks conductors to the sheath as a sturdy integral unit. A greater number of finer strands in power and ground conductors—plus a closely woven fibrous covering around the ground conductor (to minimize mechanical working of the fine strands)—increase over-all flexibility. These two features, together, prevent the damage that constant flexing, twisting, and tension might otherwise cause.

Vulcanized in lead for extra toughness

Rome 60 mining cables are built for rugged duty, both above and below ground

These tough Rome cables have a much longer service life than ordinary cables. This is of dollars-and-cents importance to you because it can mean less down time, reduced replacement expenses, and increased production.

Here are some of the construction features that make Rome 60 cables your best mining cable buy:

Conductors. All conductors are of finely stranded copper wires for maximum flexibility.

Insulation. A long-aging, heat- and moisture-resistant rubber compound permits operation at 75° C., thereby providing overload protection. For high-voltage service, an ozone-resistant insulation is used.

Reinforcements. On Rome 60 portable cables, a heavy reinforcing open braid locks the Neoprene jacket to the inner construction to prevent failure from twisting, pulling, flexing and sheath separation.

Jacket. Neoprene vulcanized in a continuous lead mold provides durability and high resistance to abrasion, acids, oils and flame. All Rome 60 mine-trailing cables are surface-molded "P-105 BM" indicating full compliance with Federal and State of Penn. safety codes.

Specify Rome 60 mining cables for your next job. Contact your nearest Rome Cable representative for more information—or write to Department 176, Rome Cable Corporation, Rome, New York.

ROME CABLE
CORPORATION

Coppus VENTAIR (centrifugal type)

Coppus VANO (propeller type)

Choose between them and get 30% to 100% more air

Coppus Blowers are designed for two different types of mine ventilation requirements: the centrifugal Coppus VENTAIR is for long pipe lines; the propeller-type Coppus VANO for shorter lines . . . the correct selection will give you from ⅓ more to twice as much air — for a given power consumption — than an ordinary all-purpose fan.

Available for either compressed air or electric motor drive, both can be used as blowers or exhausters and are obtainable in capacities up to 90,000 CFM.

Only Coppus makes both these types, one of which will give you better, more economical mine ventilation . . . know them by the "Blue Ribbon" that symbolizes the engineering and production skill behind every Coppus product.

Representatives listed in MINING CATALOGS. Other Coppus "Blue Ribbon" products: steam turbines, gas burners, heat killers, air filters, blowers and exhausters for special purposes. See also THOMAS' REGISTER . . . Coppus Engineering Corporation, Worcester 2, Mass.

COPPUS ENGINEERING CORPORATION
286 Park Avenue, Worcester 2, Mass.

Please send ..... Bulletin 130

Name .....

Company .....

Address .....

ROSS CHAIN FEEDER CONTROLLING FLOW TO UNDERGROUND PRIMARY CRUSHER OF LARGE CANADIAN BASE METAL PRODUCER

YOU WANT ROSS CHAIN FOR REAL FEED CONTROL . . .

A Ross Chain Feeder is your guarantee of perfect flow control of ANY size ores or rock . . . from storage bins and open dump chutes to crushers, conveyors, screens . . . anywhere . . . at lowest operation and maintenance cost. Other "Ross" units include Ross Drop-Bar Grizzly Feeder and Ross Two-Roll Grizzly.

Send particulars for our definite recommendations.

ROSS SCREEN & FEEDER CO.
100 Quimby Street
Westfield, New Jersey, U.S.A.

ROSS ENGINEERS LTD.
11 Walpole Road
Surbiton, Surrey, England.

CANADIAN LICENSEE: DORR-OLIVER-LONG LTD., ORILLIA, ONTARIO.

WEMCO ... WKE

EQUIPMENT SERVICES

for metallic and non-metallic mining, chemical and process industries

engineers and builders for mineral, chemical and process industries

WEMCO SPIRAL CLASSIFIERS . . . *classifying, desliming, dewatering*

For wet mechanical classification of ores and industrial minerals in closed circuit grinding and open circuit applications. Slime-sand separations from 28 to 325 mesh. Single, double or triple spirals; tank options from straight side to full flare for desired settling area. Hydraulic lifting device available for starting under load without tank drainage. Sealed bearings, replaceable wearing shoes, continuous tube shaft assure long life.

Available also in design adaptations for sand preparation, coal dewatering.

SPIRAL DIAMETER: *12" to 90"*
TANK LENGTH: *6' to 48'*
RAKING CAPACITY: *5 to 24,000 TPD*
WEARING PARTS: *Alloy iron, stainless steel, or rubber covered*

WEMCO FAGERGREN FLOTATION MACHINES: *roughing, scavenging, cleaning*

World's largest installations use WEMCO-Fagergrens, proved in competitive tests to have unequalled capacity per cubic foot of cell volume per square foot of floor space. Rotor-stator principle promotes optimum pulp circulation and aeration for high metallurgical efficiency. New air control gives increased cleaning efficiency.

Pulp transfer accomplished by special feed boxes, eliminating much troublesome and expensive pumping. Cells are simplest to operate, with minimum of adjustments.

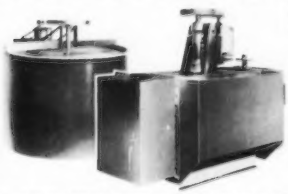
SIZE: *12" to 66"*
CAPACITY: *1 to 50,000 TPD*
ROTOR-STATOR: *Rubber or neoprene covered, stainless, or alloy iron*
TANK: *Steel, wood, stainless, cement or rubber lined*

WEMCO ATTRITION MACHINES . . . *scouring, scrubbing*

Designed to produce an efficient inter-particle impingement in dense pulps of 65% to 80% solids, for scouring pulp grains, removing organic coatings or previously used reagents, breaking up and removing clay and slime inclusions. Reverse propeller blade action produces ultimate in pulp mixing with minimum contact time.

Bearings, housing, other parts interchangeable with Wemco-Fagergren Machines, Wemco Agitator-Conditioners, certain Wemco Vertical Pumps.

CELL SIZES: *10 or 20 cu. ft.*
WEARING PARTS: *Alloy iron, stainless, rubber or neoprene covered*
CAPACITY: *5 to 100 TPH*



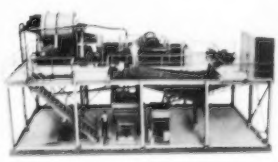
WEMCO AGITATOR-CONDITIONERS . . . *agitating, mixing, blending*

Fast, homogeneous mixing and steady, uniform feed to the next step in ore processing. Propeller type (left) for conditioning flotation pulp, reagent mixing or blending, dissolving of solids and liquids, and scrubbing applications. High intensity Fagergren type mixer-blender for reagents, other material with poor solubility characteristics.

Various parts interchangeable with Wemco-Fagergren Machines.

Turbine type agitators also available for special applications.

SIZES: *Propeller type, tank sizes from 2' to 20' diameter*
High-intensity type, cell sizes 2 cu. ft. to 100 cu. ft.
WEARING PARTS: *Alloy iron, stainless, rubber or neoprene covered*



WEMCO MOBIL-MILLS . . . *greatest efficiency in HMS*

Pre-engineered and pre-fabricated from standardized Wemco designs for maximum efficiency and flexibility in Heavy Media Separation. Mobil-Mills are used to produce marketable concentrates and for low cost elimination of waste in treating metallic minerals, industrial minerals, coal and industrial gems.

Wemco's long experience is your assurance of efficient design, producing by far the lowest cost per ton treated. Wemco Mobil-Mills are flexible in design, using either drum or cone separators as required; can be dismantled and moved if required.

SPECIFIC GRAVITY RANGE: *1.25 to 3.40*
CAPACITY: *5 to 500 TPH*
SEPARATORY VESSEL: *Cone, Single Drum, Double Drum, 2-Compartment Drum*

WEMCO DENSIFIERS . . . *dewatering and stabilizing HMS media*

One of many reasons for fine performance of the Mobil-Mill is use of a densifier, which provides a constantly available storage of thickened, conditioned and stabilized HMS medium. The Densifier acts as a buffer in preventing over-correction of separation gravities; eliminates need for complex automatic controls.

TYPE: *Straight tank, flared tank*
SPIRAL DIAMETER: *12" to 66"*
TANK LENGTH: *9' to 35'*
LIFTING DEVICE: *Manual or motorized*

WEMCO SEPARATORS . . . *clean HMS separation with drum or cone*

DRUM TYPE — Clean gravity separation in particle sizes from ¼" to 10". Float material overflows; sink material is raised by lifters which are an integral part of drum. No internal moving parts to wear or cause shutdown. 2-Compartment Drums produce a true sink, true float and middling. Double drums make two separations.

CONE TYPE — For extremely sharp separations, 10 mesh to approximately 4 inch. Large pool area minimizes small particle entrapment. Float material overflows; sink material removed by means of airlift from bottom. Furnished complete with stirring mechanism, airlift assemblies, drain plugs and fittings, feed and medium return hoppers, discharge launder.

SIZE:
Drum: 4' x 4' to 12' x 12'
Cone: 3' diameter to 20' diameter

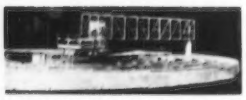
CAPACITY:
Drum: 5 to 450 TPH
Cone: 2 to 600 TPH

WEMCO REMER JIGS . . . *close gravity separation of large tonnages*

Ideal for treating large tonnages of ores where specific gravity differential exists. Separates 3 products: high gravity fine, high gravity coarse, and light gravity material.

Differential Acceleration (combined high and low frequency strokes) provides live jig bed over entire surface, maximum hutching capacity for recovery of high gravity fines, complete stratification and separation in coarse bed products. Patented WEMCO-Remer system uses roughing, scavenging, cleaning circuits.

TYPE: *Two hutch, three hutch*
SIZE: *5' x 11' to 5' x 16'*
CAPACITY: *30 TPH to 60 TPH per unit*



WEMCO HYDROSEPARATORS-THICKENERS . . . *desliming, thickening, clarifying*

Hydroseparators: Economical desliming - dewatering in minus 200 mesh range. Closely controlled agitator frees sand, adequate weir length reduces velocity preventing loss of desirable sands in overflow.

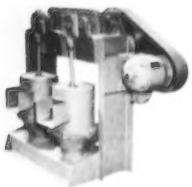
Thickeners: Produce a dense pulp for further treatment or recover process water solutions in flotation, leaching, cyanidation, and HMS flow sheets. Used in preparing feeds for flotation machines, filters, dryers, kilns, conditioners, magnetic separators, repulpers in counter-current decantation.

TYPE: *Beam, truss, center pier*
SIZE: *Hydroseparators, 6' to 70' dia. Thickeners 6' to 350' diameter*
LIFTING DEVICES: *Manual or motorized*
CONSTRUCTION: *Standard or acid-proof as required*

WEMCO TORQUE FLOW SOLIDS PUMP . . . *unique, clog-free operation*

Unique design permits handling a large percentage of solids with negligible degradation, at steady discharge pressures with minimum wear. Torque flow principle and open impeller design permits passage of large solids and tramp material without entrapment or clogging.

SIZE: *2" x 2" and 3" x 2" to 8" x 8" and 10" x 8"*
CAPACITY: *50 GPM to 3000 GPM*
HEAD: *Up to 100 feet*
CONSTRUCTION: *Ni hard for abrasive service*



WEMCO DIAPHRAGM PUMP . . . *efficient operation, simplified servicing*

Unmatched for handling dense pulps, sludges and other fluids containing solids which wear or clog other pumps. Ideal for controlling hydroseparator and thickener underflow. Adjustable speed and stroke. Engineered for fast takedown and replacement of parts subject to wear.

SIZE: *2" to 4" Simplex and Duplex*
CAPACITY: *5 to 100 GPM*
CONST.: *Fine grained iron, rubber valve seats, stainless steel or rubber covering available for certain duty.*

WEMCO SAND PUMPS . . . *reliable service in toughest jobs*

Universally used for pulps containing sands, abrasive solids, slimes, slurries and heavy media; for pumping mill tailings, flotation feed, concentrates and tailings, for HMS circuits, screen products and grinding mill discharge to classifiers. Operation is simple. Complete change of wearing parts can be made in minutes by unskilled labor with simple tools.

SIZE: *1¼" to 8"*
CAPACITY: *20 GPM to 220 GPM*
DISCHARGE HEAD: *Up to 100 feet*
PULPS HANDLED: *Up to 65% solids, particles up to 1". (2" size available with rubber covering on all parts contacting pulp)*

WEMCO VERTICAL SAND PUMPS . . . *added flexibility*

Same exceptional performance characteristics as pumps above, but with added applications because of vertical design. Used for any vertical sump duty including clean-up. They can be mounted inside flotation concentrate launders for pumping concentrates.

SIZE: *1¼" to 4"*
CAPACITY: *20 GPM to 500 GPM*
PULPS HANDLED: *Up to 65% solids, particles up to ¾". (Rubber covering available on 2" size where required)*

WKE ENGINEERING, DESIGN, CONSTRUCTION

In its W. K. E. Division, Western Machinery Company maintains an organization with facilities to render a complete service in preliminary investigations, engineering, designing, plant construction from simple storage facilities to complete process.

With more than 20 years' experience in the field of industrial raw materials processing, W. K. E. provides the specialized experience, sound technical background and high quality results essential to the design and construction of profitable plants.

WEMCO

K WESTERN MACHINERY COMPANY

E WESTERN KNAPP ENGINEERING CO. (Division)

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Licensees and Representatives in Mining Areas Throughout the World

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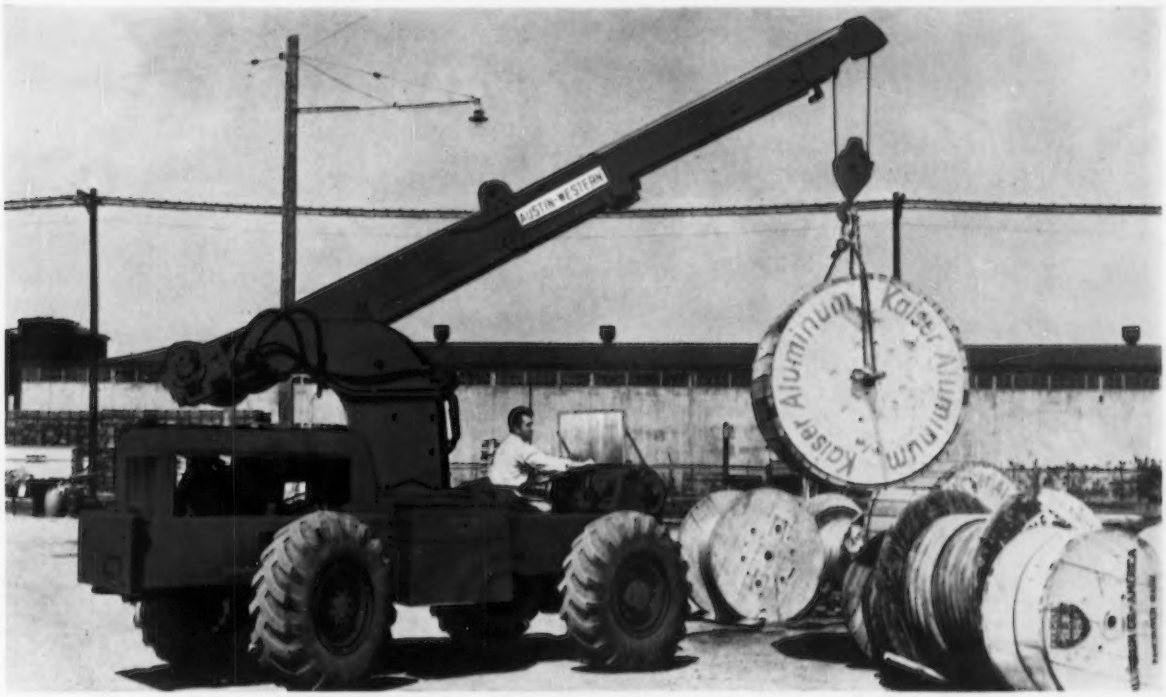
Bulletin No. G2-B22



CUT MAINTENANCE COSTS WITH AUSTIN-WESTERN

A-W Hydraulic Crane for faster precision lifting

This is the most versatile machine yet designed for all-around lifting jobs. Carries loads up to 5 tons, swings, lowers, and spots them into exact position. All boom movements—raising, lowering, swinging and telescoping—have finger-tip hydraulic controls that can be used individually or simultaneously. All-wheel steer and a 15 ft. 8 in. turning radius take it in and out of tight spots, indoors and out. All-wheel drive and oversize tires make easy going of railroad tracks, rough or snowy terrain. Can haul and spot cars on your sidings, yard or pit. Usually pays for itself in the first year by speeding repair jobs, reducing downtime, and saving labor.

A-W Motor Grader for the tough road jobs

A-W Motor Graders with all-wheel drive give you 30% more power where it counts—at the blade—than ordinary graders with dead front ends. Building and maintaining access and haul roads under conditions like those shown at left demand the kind of tractive effort that only all-wheel drive can give. With a bulldozer attachment (shown at left), A-W's power and ruggedness often save the cost of a tractor-bulldozer.

Get complete information from your A-W distributor or write direct

Power Graders • Motor Sweepers • Road Rollers • Hydraulic Cranes

BALDWIN · BLH · LIMA-HAMILTON

AUSTIN-WESTERN WORKS
BALDWIN-LIMA-HAMILTON
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AURORA, ILLINOIS, U.S.A.

Barber-Greene Idlers provide extra years of low cost operation . . . the ultimate in belt protection.

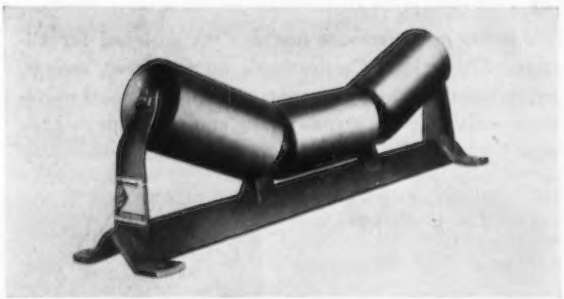
Barber-Greene Idlers . . . still rolling after twenty years

Installed 20 years ago, Barber-Greene Idlers are still rolling at this Material Service Corporation plant in Chicago.

There are no secrets behind the long-life records established by Barber-Greene Idlers. Advanced design plus top-quality materials, plus precision manufacture with the most modern production machines make the difference. The user benefits in lower maintenance costs, less down time, and longer idler life.

Barber-Greene advantages include virtually unbreakable jig-welded base frames, self-shedding base angles, interchangeable rolls made of heavy steel tubing, seamless steel grease reservoirs of ample capacity, and two-degree tilt to facilitate belt alignment.

Whether it's a ball bearing unit for normal service, or a roller bearing unit for the most rugged conditions, Barber-Greene has the idler that's right for any conveyor . . . right for any job.



Available in widths from 16" to 60", with 4", 5", or 6" rolls, the Barber-Greene line includes standard troughing carriers and return rolls, flat belt and picking table carriers, self-aligning carriers and return rolls, grain idlers, rubber impact carriers, and self-cleaning return rolls.

56-22-1PE

Write for literature on the complete Barber-Greene idler line.

Barber-Greene

AURORA, ILLINOIS, U.S.A.

CONVEYORS . . . LOADERS . . . DITCHERS . . . ASPHALT PAVING EQUIPMENT

Ask the man WHO HAS USED BOTH!

HE WILL TELL YOU WHY he replaced his other car spotters with STAMLERS!

WE SAID it before and we say it again: DON'T BELIEVE US — *just ask the mining men who have had experience with STAMLER Car Spotters and with other car spotters.* Then you will know why they switched to STAMLERS. Then you will believe that during the past year STAMLERS have replaced other car spotters many times in many, many mines. And the shift to STAMLERS continues at an increasing pace! But there's really no mystery about it. It's just that STAMLER equipment out-performs all other loading point equipment; that STAMLER equipment increases tonnage and reduces costs; that STAMLER equipment operates at the lowest possible maintenance figure! *When are you going to join the swing to STAMLERS?*

STAMLER *Hydraulic* **CAR SPOTTERS**

SCHROEDER BROS., Exclusive Eastern Sales Agent
Pittsburgh, Pennsylvania
UNION INDUSTRIAL CORP., Carlsbad, New Mexico

W. R. STAMLER CORPORATION
PARIS, KENTUCKY

SALMON & CO., Birmingham, Alabama
WESTERN SALES ENGINEERING CO.,
Salt Lake City, Utah

GENERAL REFRACTORIES

A COMPLETE REFRACTORIES SERVICE . . . *for the Copper Industry*

Three types of basic brick—RITEX, GREFCO, STEELKLAD for the three basic processes—smelting, converting and refining. Each type of brick available in the ranges of composition—Magnesite, Magnesite-Chrome, Chrome-Magnesite and Chrome—required to adapt to variations in metallurgical processing.

RITEX—chemically bonded for low cost, superior workmanship, resistance to spalling, ready availability.

GREFCO—conventional type bonded by tunnel kiln high temperature firing, for maximum strength and hardness.

STEELKLAD—steel encased on two, three or four sides and for special jobs, steel plates incorporated in the brick interior as well—for maximum resistance to spalling in the most severely treated exposed walls.

RITEX, GREFCO and STEELKLAD—each the result of many years of intimate knowledge of the copper industry and careful study of service conditions, each prepared from the best available raw materials and made with the most modern manufacturing facilities—all within easy access to your operation.

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HOLLOW DRILL STEEL—Crucible drill steel is available for any drilling job—in both carbon and alloy grades—and in a full range of sizes and shapes.

CARBON:
Crusca Hollow Drill Steel is the popular straight-carbon type—standard throughout the world. It's an easy to work with, all-purpose drill steel for jobs not requiring the tougher alloy grades.

ALLOY:
CA Double Diamond Alloy Hollow Drill Steel has greater hardness, higher strength than straight-carbon grades. It has superior resistance to fatigue, wear and abrasion.

4E Alloy Drill Steel is designed for the really tough jobs. Its resistance to fatigue, and its high-strength, are unmatched.

Crucible produces all these grades to *tool steel quality standards*. That means fewer broken rods—less valuable bit loss—*lower cost per foot of hole drilled.*

for the mining industry...

special steels *by* CRUCIBLE

ALLOY STEELS
Bars, billets, rods, plate, sheet, strip, wire, and special shapes in all standard AISI grades and many special analyses for . . .

car axles
chutes and conveyors
shaker screens for rock and ore crushers
coal cutting and loading machinery
drill bit bodies
bits and chisels

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Sand castings for pump parts
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Welding electrodes and hard facing rods for . . .

hard facing screens, crushing and handling equipment,
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Alnico permanent magnets for magnetos and impulse generators for blasting, miner's lamp safety locks

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STAINLESS STEELS
Heat and corrosion resistant stainless in all grades, types, and mill forms for . . .

vats and receptacles handling corrosive flotation materials,
pump rods
plates and angles for mancars
sifting screens

TOOL STEELS
all grades, sizes, and types for general tooling, and equipment maintenance.

Next time you need hollow drill rods—or *any* type of special purpose steel—the man to call is your local Crucible representative. He can insure immediate deliveries from warehouse stock, or prompt mill shipments. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Cedarapids Built by IOWA

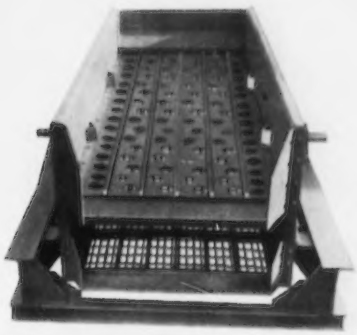
HEAVY-DUTY EQUIPMENT FOR CUTTING PROCESSING COSTS

Cedarapids equipment is engineered with all the features essential to low-cost ore handling. Each unit is built for the *extra strength* necessary for heavy-duty service in the world's most rugged industry. Each unit is designed by experts in the field for *high capacity* production. The "proved-in-service" *low maintenance* costs of Cedarapids equipment is another bonus feature that helps you cut processing costs. Investigate Cedarapids advantages today!

HEAVY-DUTY APRON FEEDERS

ASSURE SMOOTH, WORKABLE FLOW OF ORE

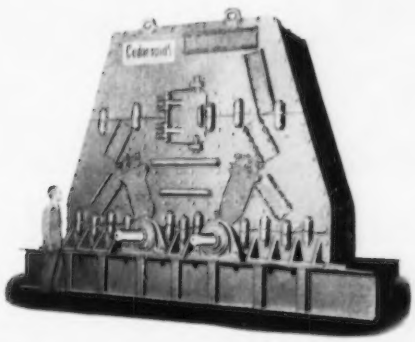
This big 40" x 12'4½" Apron Feeder is especially designed for smooth feeding of heavy, large-size material. Rugged construction, with 9 shafts beneath the heavy cast steel flights, withstands the dumping of heavy loads into the feeder.



HEAVY-DUTY SCALPING SCREENS

COMBINE BIG-VOLUME PRODUCTION WITH LOW MAINTENANCE COSTS

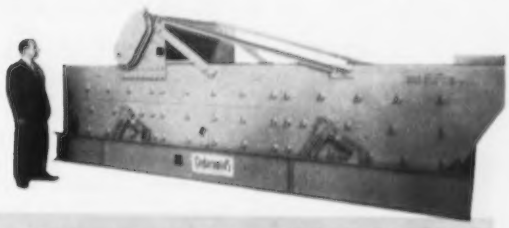
Cedarapids Inclined Double Deck Vibrating Screens are sturdily built to handle 2 to 3-ft. material. Eccentric shaft vibrating mechanism provides positive circle throw to assure big-volume output. Easily replaceable plate feed box and discharge lip reduce maintenance costs.



DOUBLE IMPELLER IMPACT BREAKERS

FOR PRIMARY AND SECONDARY CRUSHING IN ONE OPERATION

Double Impeller Impact Breakers are being used for more and more mining applications because of their exceptionally high output, design which permits a high percentage of material to be broken in suspension to minimize wear and reduce power requirements and the high reduction ratios which eliminate the need for secondary crushers in many instances. It will pay you to investigate all the many other advantages of Double Impeller Impact Breakers.



HORIZONTAL VIBRATING SCREENS

GIVE ACCURATE GRADATION—MAXIMUM CAPACITY

Many screen deck arrangements of Cedarapids Double and Triple Deck Screens in sizes up to 60" x 16' will give accurate gradation and maximum capacity for mining operations. Special underslung drive arrangements are available for applications where the headroom is limited or large oversize is encountered.

See your nearest Cedarapids Distributor for complete details

IOWA MANUFACTURING COMPANY
Cedar Rapids, Iowa, U.S.A.

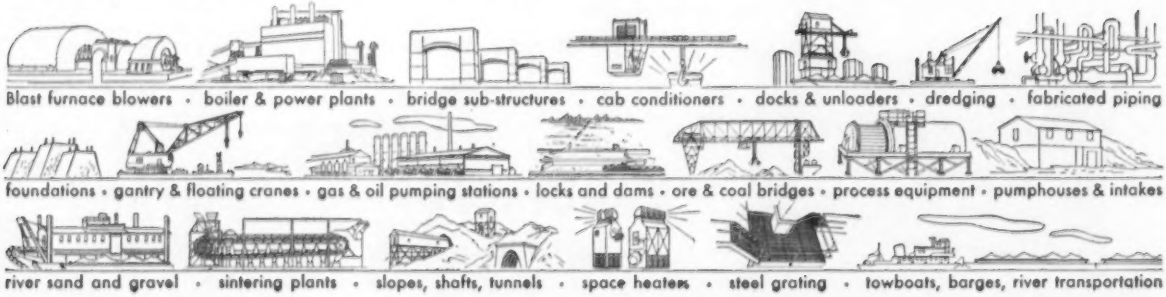
DRAVO-LURGI sinter plants convert iron ore fines to usable form

Two new sinter plants, with a combined annual capacity of over 10,000,000 tons, are being built by Dravo. Each plant will contain three huge sinter machines for processing iron ore fines into clinkers suitable for charging blast furnaces.

Through an exclusive licensing agreement with the Lurgi Company, Europe's foremost builder of sinter machines, Dravo Corporation's extensive engineering and construction facilities are combined with Lurgi's design experience. The new plants now under construction are a result of this combination.

Dravo's engineering and construction skills play an important part in making new processes and techniques available to industry. For information on any of the products or services listed below, write DRAVO CORPORATION, PITTSBURGH 22, PENNSYLVANIA.

DRAVO
CORPORATION


Blast furnace blowers • boiler & power plants • bridge sub-structures • cab conditioners • docks & unloaders • dredging • fabricated piping
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NOW...boom pendant assemblies with full catalog strength of the wire rope

Rugged J&L boom pendant assemblies with exclusive JalKlamp splices provide extreme strength, longer service life.

JalKlamp terminals are formed by hydraulically pressing the alloy sleeve around the rope. The metal in the sleeve flows into every space between the wires and the strands of the rope. The splice is up to 20% stronger than conventional splices.

The solid steel fittings in J&L boom pendant assemblies are held tight in the loop. They cannot slip.

Investigate why J & L boom pendant assemblies last longer under toughest operating conditions. Send coupon today for complete information.

Jones & Laughlin
STEEL ...a great name in steel

Jones & Laughlin Steel Corporation
Wire Rope Division
Muncy, Pennsylvania

☐ Please send information on J&L boom pendant assemblies.

☐ Have representative call.

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Title_____

Company_____

City_____ Zone____

State_____

Edison Electric Cap Lamps

The Edison Model "R-4" Electric Cap Lamp has gained world-wide approval from modern miners for its brilliant illumination, steady dependability, and reduced handling requirements. Because more and better light is always on the job, the Edison R-4 permits men and machines to produce at their top level of output. Write for details.

Permissible Mine Lighting Systems

These systems provide supplementary illumination to electric cap lamps, principally in working areas, to make operation safer and more efficient. They provide portable lighting with an instant start circuit that is safe under any and all mining conditions. On-the-job testing proved less accidents, more output. Write for details.

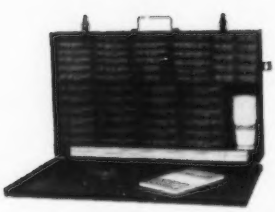
MSA's complete product line boosts

M-S-A Self-Rescuer

Emergency breathing protection against carbon monoxide and smoke. Light and comfortable. Individual carrying case, or cache assembly for underground storage.

M-S-A Dustfoe Respirator

Lightweight, comfortable breathing protection against dusts not significantly more toxic than lead. Fast, easy cleaning. Improved job vision. Modern, functional design.



M-S-A First Aid Kit

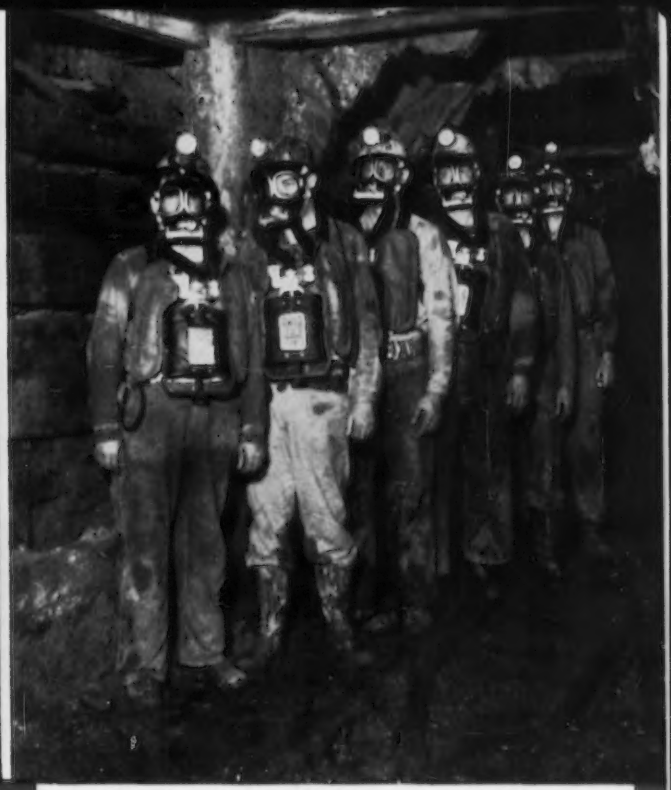
Ideal for mine hospital, dressing station and emergency use. Comes with assortment of medical dressings individually packaged in cellophane. Contains clear, concise instructions.

M-S-A Trip Lamp

Equipped with the Edison R-4 battery to provide illumination at all angles. Rectangular shape, small size, with strong forged steel hook for hanging on back or side of mine car.

MSA

SAFETY EQUIPMENT HEADQUARTERS



Communications

M-S-A Communication Systems keep things moving safely, speedily. M-S-A HoistPhone (above), provides dependable, continuous two-way voice communication at any level, and while cage is in motion. M-S-A MinePhone improves haulage efficiency and safety, by dispatching messages instantly to all motormen, who can receive and reply while trips are in motion. Write for details.

Respiratory Protection

Because no *one* breathing apparatus gives the best protection for every job, complete selection is all-important. You get this advantage at MSA. We have a complete line of breathing protection apparatuses designed for vital fire-fighting and rescue work. M-S-A Chemox® is shown above. Write or call in one of our representatives for a check of your requirements.

tonnage output with increased safety

M-S-A Pneolator®

Provides automatic artificial resuscitation that assures maximum chances of recovery for victims of arrested breathing. Completely self-contained. Easy-to-carry glass fiber case.

M-S-A ChemKlos

Made throughout of Dynel, these serviceable, gray work clothes resist acids, caustics, mildew, moths. Styled for comfort, good looks. Available in coveralls, trousers and shirts.

M-S-A Skullgards

Tough, rugged, laminated shell construction dissipates the force of impact—unaffected by oil, water or perspiration—comfortable suspensions cushion blows.

M-S-A Rail Punch

Designed for quick economical hole punching through web section of steel mine rails for efficient track repairs. Needs no external power connection. Easy to operate.

MINE SAFETY APPLIANCES COMPANY

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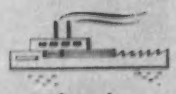
Kleenslot

WEDGE WIRE PREPARATION SCREENS

mining



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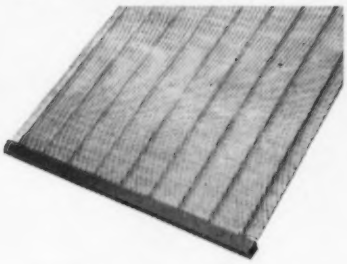
FOR DEWATERING, SCREENING, WASHING, EXTRACTING, FILTERING or SIZING APPLICATIONS

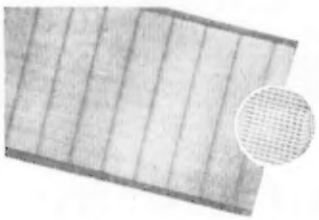
SCREEN GUARDS

A new innovation in the mining and industrial field. Particularly adaptable for use in flumes. The screen guard is built right into the screen and the vertical guard bars keep the larger lumps of material above the guard bars, permitting only the finer particles to pass over the screen. Special sizes can be furnished.



VIBRATOR SCREENS

They can be designed and adapted to fit any make of vibrator. You do not have to change your present machine to accommodate this screen. It is of quality construction and built to give maximum service. The rigid construction and method of installation prevents "whipping".



MARCEL-TYPE SCREENS

This screen is entirely different inasmuch as it is of a Marcel-type construction. It was designed for operations where slivers passing through are objectionable in the end product. This screen can be made in all sizes and shapes wherever applicable to higher and productive efficiencies. It gives long life and non-blinding operation.

ALUMINUM SCREENS

This aluminum screen has all of the attractive and sturdy features of many other metals. In addition, it offers flexing action that adds capacity and dewatering abilities which are almost unbelievable. No changes are necessary in the body of the screen to effect its installation.

NON-BLINDING — NON-CLOGGING - LONGER LIFE - MOST ECONOMICAL

The diagram at left shows all of the efficiency that can be furnished to you by KLEENSLOT Wedge Wire Preparation Screens, inasmuch as the wedge construction permits easy clearing. KLEENSLOT Wedge Wire Screens can be furnished in practically any type of metal. It costs nothing to obtain a Wedge Wire recommendation free of charge. Complete literature is available for the mining, oil, food, chemical and abrasives industry. There is a KLEENSLOT Wedge Wire Screen for every application.

★

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- SOIL SAMPLING
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B-52 pacemaker

HYDRAULIC ROTARY DRILL

with the exclusive HOLLOW STEM AUGER... lets you sample while you bore!

time-saver no. 1

22' TOWER—Permits withdrawal of rods in 20' lengths. Mechanically operated, jackknifes to horizontal position for safe, legal highway travel.

time-saver no. 2

OFF-THE-HOLE HYDRAULIC BASE—Rail-mounted base slides out of way while adding or withdrawing drill sections, assures continuous perfect alignment. Hydraulically operated.

time-saver no. 3

CENTRALIZED 1-MAN CONTROL GROUPING—Located on operator's side of drill base, within easy reach. Fingertip controls plus advanced safety design increases operator's efficiency.

time-saver no. 4

NEW, *EXCLUSIVE* HOLLOW STEM AUGERS—Actually permit all types of sampling while you bore! Augers form their own casing, also allow coring through hollow stem after rock has been reached.

ONLY 4-in-1 RIG ON THE MARKET! . . . Mobile Drill's new B-52 PACEMAKER brings unequalled versatility to contractors, prospectors, highway departments, soil sampling labs, aggregate producers and others who need greater drilling speed and flexibility. Here's a rugged, powerful, heavyweight workhorse that drives 6' sectional augers to 150' . . . N rods to 600' . . . and A rods to 1,000'! New spindle type drive tube provides easy accessibility to both auger couplings and rod chucks, makes the B-52 a "quick change" artist in the field.

BIG POWER . . . BIG PERFORMANCE! PACEMAKER's twin hydraulic feed has fingertip control, gives up to 5 *tons* (10,000 lbs.) hydraulic ram force! Rig has own independent power plant, variable speed control on rotary drive.

EQUAL TO 2 ORDINARY RIGS! Without the new PACEMAKER, you'll need at least two standard rigs to get the same number of jobs done! It can be operated by 1 man . . . seldom requires more than 2, even on the toughest jobs!

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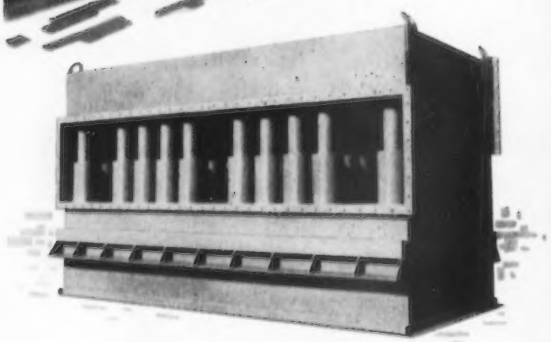
Turning DUST into DOLLARS

. . . created a job for WHIRLEX in one of the world's largest iron ore mining operations

21 WHIRLEX collector and Fan units . . . 21 CARLOADS

Taconite dust is very abrasive and is recognized in the mining industry as being one of the roughest of materials on process equipment. The selection of "WHIRLEX" Collectors and Fans supplied for this application resulted from a rigid field test of full sized pilot equipment, over a period of several months. The pilot operation definitely proved that the equipment consistently performed with high collection efficiency under extreme variable conditions, and also was rugged enough to withstand the severe erosive effects of heavy concentrations of Taconite dust.



The Type MTSA-9CY18S Multiple Cyclone Collector is especially designed to operate at high collection efficiency with excessive dust loads. Extra heavy, all welded, steel elements and casings insure a long service life with minimum maintenance requirements. The open type construction employed provides convenient access to all working parts.

Patented

Inquiries on special dust problems are solicited. Descriptive literature will be furnished on request.

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Athey PR15-Cat DW15 has 22-ton capacity and top speed of 37.2 MPH for high-speed hauling and dumping.

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Athey PD20-Cat DW20 has 30-ton capacity, speeds up to 32.1 MPH, dumps "on-the-go," for non-stop cycles.

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for your specific hauling needs

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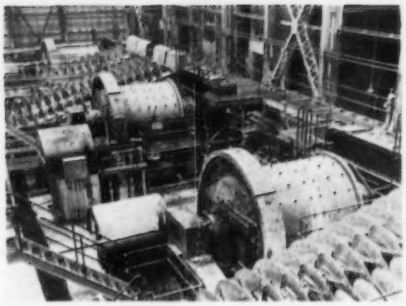

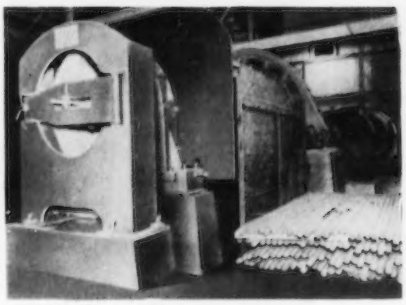

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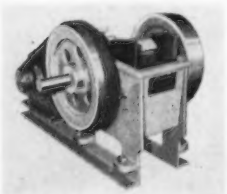
For separation of any material amenable to gravity concentration.

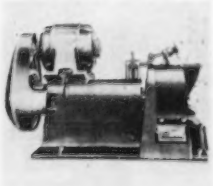
Marcy Pulp Density Scale
Gives direct readings.

Massco-Grigsby Pinch Valves
Rubber and neoprene sleeves. 1" to 14".

6" x 10" Massco Gy-Roll Reduction Laboratory Crusher



4" x 6" Massco Laboratory Jaw Crusher



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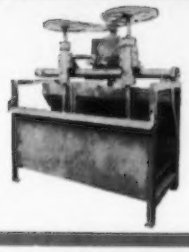

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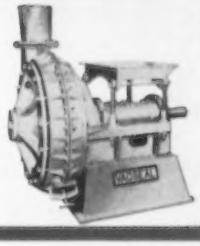
A complete line of solids handling and acid pumps. Sizes 1½" to 8".



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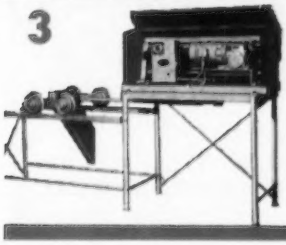

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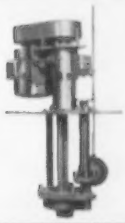

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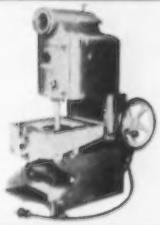
500, 1000, 2000 gram employing the same principle of flotation as the world-famous commercial AGITAIR®.



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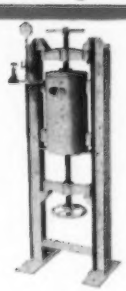

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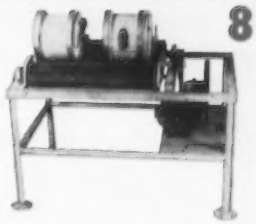

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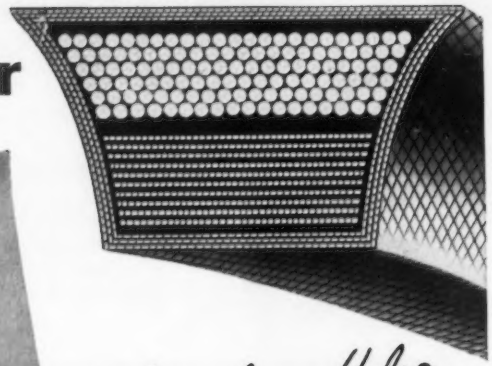
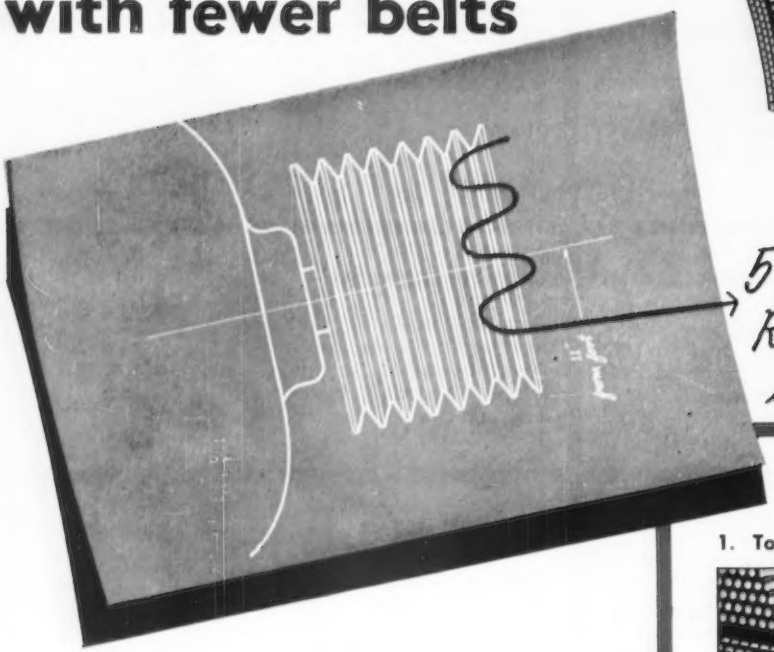
Cut sheave width and weight...

get same horsepower with fewer belts





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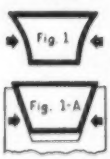
2. Concave Sidewalls (U.S. Pat. 1813698)



Concave sides (Fig. 1) increase belt life. As belt bends, concave sidewalls become straight, making uniform contact with sheave groove (Fig. 1-A). Uniform contact means less wear on sides of belt . . . far longer belt life.

3. Flex-Weave Cover (U.S. Pat. 2519590)

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TPA 248

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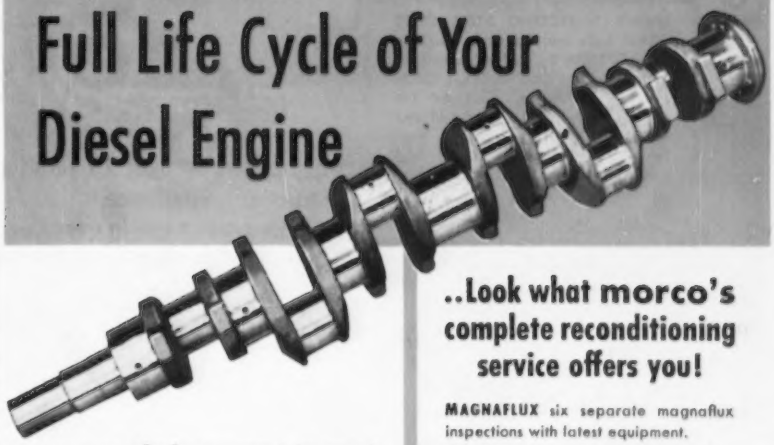

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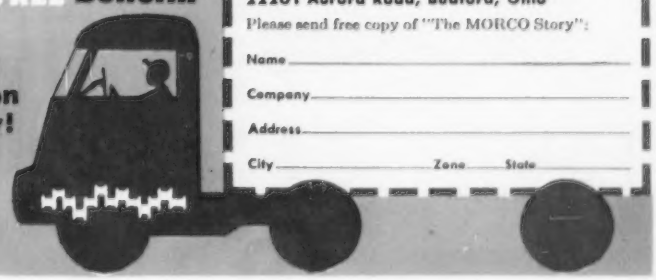

MORCO, Inc.—Dept. 6
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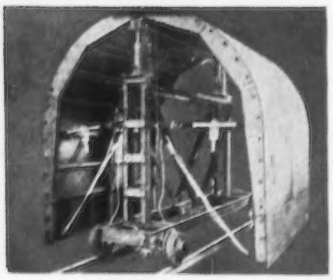


MAYO TELESCOPIC STEEL DRIFT FORM built for the main haulage tunnel, 10′ x 11′, of an important Pennsylvania iron mine. Other Mayo steel forms, designed for specific jobs in other parts of the world, include: telescopic, non-telescopic, separate sidewall and arch, single unit, full round forms for monolithic pours, etc.

YOU CAN DEPEND ON MAYO

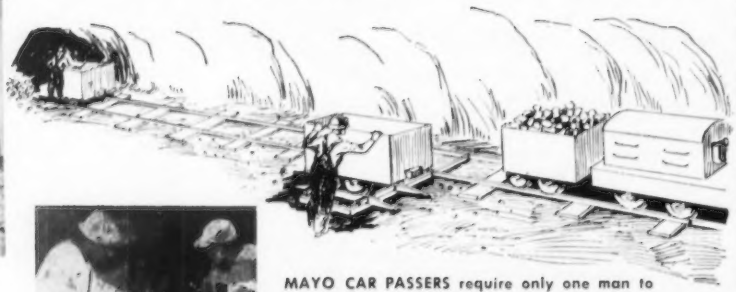
TUNNEL and MINE EQUIPMENT

. . . based on over 25 years of specialized design and construction experience

. . . proved in use in every part of the world. For more complete information, send for FREE, 8-PAGE BULLETIN NO. 22

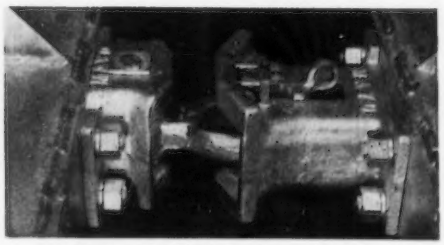
SPECIAL EQUIPMENT DEVELOPED FOR SPECIAL PROBLEMS

MAYO HEAD FRAMES—for deep or shallow shafts. MAYO SINKING FRAMES—for quick erection and dismantling. Each designed and built for specific installations. Depend on Mayo's world-wide experience to provide the most practical answer to your problem.



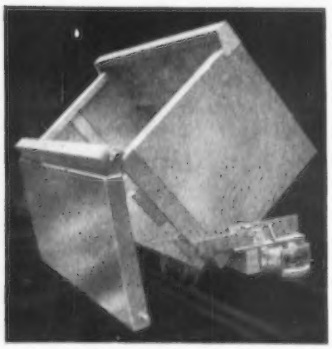
MAYO CAR PASSERS require only one man to operate, two to carry. Low in first cost, they're safe and efficient in use.

MAYO PNEUMATIC GROUTERS have proved dependable, efficient machines for placing low pressure grout in tunnels, mines, shafts and sub-grades. Readily convertible for shooting Pea or Birds-Eye gravel. Always kept in stock for immediate shipment.



. . . the coupler with the mating instinct

MAYO AUTOMATIC COUPLERS for Mine Cars couple instantly on tangent or curves. Safe, self-centering link completely eliminates all hazards of hand coupling . . . more than pays for itself by preventing accidents. Easily bolted to existing cars.



MAYO MINE CARS are of several types. Illustrated is a 2½ cu. yd. Side Dump Car, 24″ gage of the Granby type. Rocker Dump cars also available. All Mayo cars can be equipped with the Mayo automatic coupler.

MAYO

TUNNEL and MINE EQUIPMENT

LANCASTER, PA., U.S.A.

- Skips and Cages
- Kibbles and Gilleys
- Drill Jumbos
- Air Locks
- Tunnel Shields
- Mine Locomotives

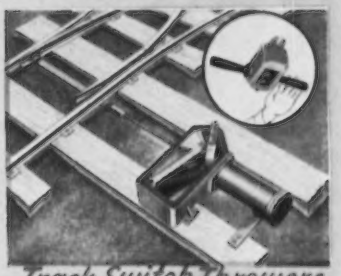
Half Century Rugged, Dependable profit-paying Equipment

A·M·D·CO

Canton Mine Door

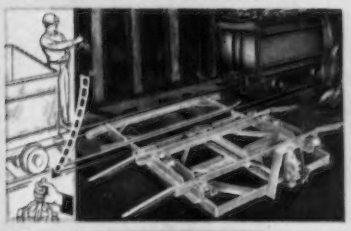
The Automatic Door operates mechanically by weight of car on activating levers. Air power operation may be had where desirable. Operates at any trip speed. Two doors provide air lock.

Install "Canton" American Mine Door Products in your Mine. Pay us out of increased profits.



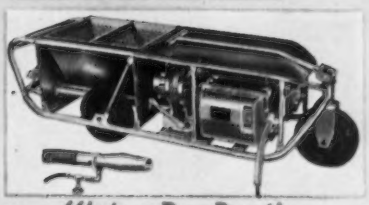
Track Switch Throwers

Electric or air operated. Route selections made by motorman at full trip speeds. Eliminates accident potential and extra man. Also ideal as Derailer.



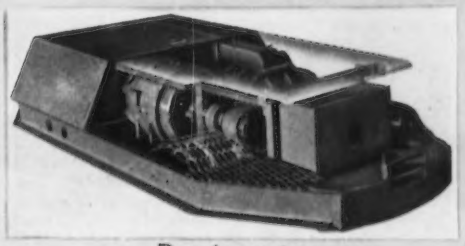
Canton Car Transfers

No alterations to track. Quickly installed and relocated—less rib to shoot than for jump switch—no hazards of cherry picker. Anti-friction bearings for easy hand operation. Manual or compressed air models available. (Air model illustrated.)



Wet or Dry Dusting

"Canton" Little Chief goes anywhere . . . rubber tire model 22½" high; skid model 18½" high for shuttle buggies, belts or mine cars; track-mounted for haulage roads. Delivers 34 to 60 lbs. dust per minute through 50 to 400 ft. 1¾" hose.

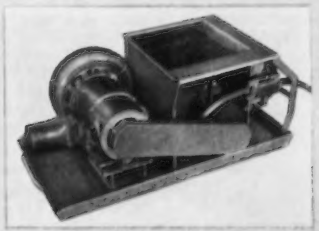


Dustmaster

The Track Mounted Hi-Pressure "Dustmaster" is the most powerful Duster ever built. Distributes dust to back areas 500 ft. from haulway.

Canton Track Cleaners

Hydraulic controls throughout clean entire track area mechanically in one pass—no costly hand labor; no dozers or loaders required. Now operating economically in coal, iron, copper, lead, potash, and salt mines.



Mighty Midget

Weighs only 280 lbs. Easily moved on shuttle car. Hand cart available. Ideal for small mines . . . inexpensive . . . capacity 7 tons per shift

Canton Cable Splicer

"Canton" Cable Splicers reduce down time in splicing cable. Machine men should carry a pocketful. Just pound around cable and go on working. No special tools.

Canton Vulcanizer

Restores insulation to original condition. Used with Canton Splicers, strong as original cable.

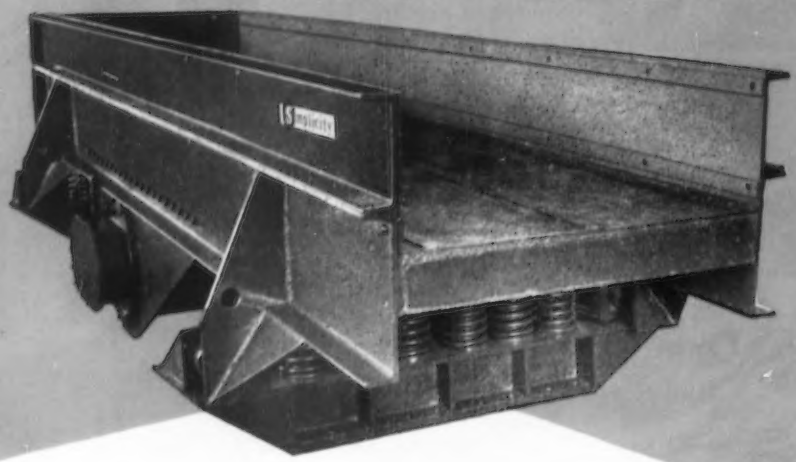
The American Mine Door Company

2039 Dueber Ave., Canton 6, Ohio

Write for complete brochures. Please use street and zone numbers.

VIBRATING PAN IS THE ANSWER!

Simplicity OS-A-VEYOR feeders lower maintenance and increase operating efficiency . . . LIMESTONE to TACONITE ORE



These Simplicity vibrating pan type feeders have proven themselves throughout the mining and quarry industry. They are not only handling various types of stone and aggregate, but the extremely abrasive taconite ore.

Lower maintenance costs have been proven by long experience in the field. The simplicity of the pan construction allows the unit to be easily repaired with existing materials. These feeders are available with replaceable liners of abrasion resistant steel. The oscillating action is provided by two eccentric shafts coupled to a single V-belt drive . . . leaving only one assembly and four bearings to lubricate.

The Simplicity Os-A-Veyor feeders are self-cleaning units. They experience none of the return spillage found in apron feeders. The Os-A-Veyor feeder will discharge material with a minimum fall, the height of drop is not determined by the size of a sprocket. The units are designed to handle heavy column loads. Overloading the feeders causes no damage, as there is no mechanical connection between the eccentric drive and the main frame or bin.

The Simplicity Os-A-Veyor feeders are main frame supported, or can be supported from the bin with spring and cable suspension, eliminating the need for separate concrete foundation. Sizes available range from 1' x 4' to 6' x 20' with capacities to 1000 tons per hour.

169

If you wish further information on Simplicity Os-A-Veyor feeders, grizzly feeders, horizontal screens or gyrating screens write . .

SALES REPRESENTATIVES IN ALL PARTS OF THE U.S.A.
FOR CANADA: Simplicity Materials Handling Limited, Guelph, Ontario
FOR EXPORT: Brown and Sites, 50 Church St., New York 7, N. Y.

Simplicity
TRADE MARK REGISTERED
ENGINEERING COMPANY • DURAND 25, MICHIGAN

Remember this

MERRICK

guarantees

ACCURATE WEIGHT

wherever you

FEED OR CONVEY

Remarkable FEEDOWEIGHT!

A self-contained automatic conveyor scale. Has automatic gate for feed rate control. Feed regulator operates gate, without restraint on scale beam. Feeds bulk material BY WEIGHT; automatically totalizes weight of materials fed. Simple operation. Slow moving parts for long life. Easy to install, maintain.

WEIGHS AND TOTALIZES WHILE CONVEYOR IS RUNNING

WEIGHTOMETER

Gives a continuous automatic, accurate totalized weight record while material is in motion on conveyor. It weighs without interrupting conveyor service. Used with any size belt conveyor, horizontal or inclined. Guarantees an accurate and dependable constant check on production of raw and washed coal, ore, etc.

MERRICK SCALE MFG. CO.

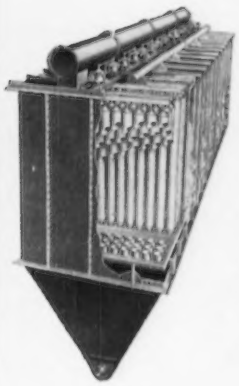
Engineers and Mfrs. of Automatic Weighing Equipment

PASSAIC, N. J.

THE NORTHERN BLOWER COMPANY

Mfrs. of Norblo Dust and Fume Collection Equipment

6410 Barberton Ave., Cleveland 2, Ohio



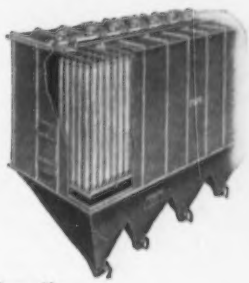
PRODUCTS: Automatic and Semi-Automatic Bag Type, H. E. L. S. Cyclone or Centrifugal Type, Hydraulic Type Dust and Fume Collectors, Cement Air Cooling System, Self-Contained or Portable Bag and Filter Type Units, Exhaust Fans . . . All designed and fabricated by our own shops.

Norblo Automatic Bag Type

For continuous or heavy duty service providing very high efficiency at very low cost of operation and maintenance. Basic unit contains 78 bags, 6" diameter, 8' 3" long. Air flow is upward, from inside, thus keeping bags fully distended. Total free cloth area per compartment 936 square feet. Shaking and cleaning controlled by electric timer, is cyclic, one compartment at a time, each having its individual compressed air shaker mechanism and the whole system variable and adjustable for dust load without shutting down. Any compartment can be cut out without affecting others. Access to interior is on the clean air side.

Norblo Standard Bag Type

For intermittent service, as fan and unit must be shut down for cleaning, usually at noon hour and end of working day. Electrical or compressed air shaking and cleaning mechanism. Basic unit has 40 bags 6" diameter, 8' 3" long, 480 square feet cloth area. In both Standard and Automatic bag types made by Norblo, extra large hoppers provide air expansion space resulting in great drop in air velocity and a maximum degree of dust separation by gravity before passing upward for final filtering.



Norblo Hydraulic

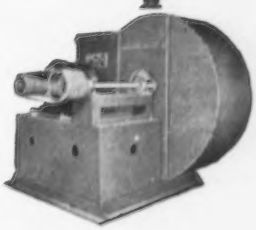
A high efficiency, wet type collector, for separation of dust mixed with smoke or fumes. In most installations the Hydraulic unit is used with a Norblo Cyclone collector, thus reducing the amount of wet sludge to be handled. There are no moving parts. Filter beds are coke or high-fired ceramic tubes, light in weight and kept in motion by ascending air stream so that beds are self-cleaning. Built in 11 standard sizes with capacities up to 26,000 cfm.

Norblo H. E. L. S. Centrifugal

A cyclone or centrifugal type collector for all materials, from saw-dust to fly ash; characterized by high efficiency of collection with low static drop. The Norblo H. E. L. S. has no internal vanes, gadgets or dampers. High efficiency is obtained by scientific proportioning and by the patented (No. 2,259,919) expanding nozzle. These design features eliminate the power-wasting back eddy. Built in standard sizes with capacity up to 37,500 cfm.

Norblo Portable Units

Self-contained units for efficient, de-centralized dust collection. Convenient, space-saving; can be located close to the dust source. Made in six sizes in bag types with capacities from 300 to 1350 cfm. All models have 8" static at fan. Fans exceptionally quiet.



Norblo Exhaust Fans

These high speed, low power fans have been developed especially for dust collecting systems and by proper wheel selection are adaptable to all types of materials handling. All wheels are statically and dynamically balanced. Heavy duty bearings are standard equipment.

HARBISON-WALKER

for dependable performance in every

SOME H-W LEADING REFRACTORIES FOR COPPER FURNACES

CHROMEX B

The desirable properties which account for the excellent service secured from this extra hard fired chrome-magnesite refractory are:—high density and impermeability—relatively low thermal expansion and good resistance to thermal shock—unusual stability and strength at high temperatures. Among the important applications for this brand in copper furnaces are its use in converter linings, complete walls of refining furnaces and vulnerable positions in roofs.

H-W MAGNESITE

For the most strongly basic linings, this refractory, consisting predominantly of periclase (stabilized crystalline magnesia), fulfills the most severe requirements. It is fired at an extremely high temperature and is dense, strong and volume-stable at temperatures far above the highest employed in copper converters. The unusually high magnesia content of this refractory, together with outstanding physical properties account for the wide preference this refractory continues to gain for use in various metallurgical furnaces.

METALKASE

Among basic refractories, Harbison-Walker METALKASE brick possess the property of maximum resistance to severe spalling conditions. METALKASE brick are furnished in various sizes and shapes. They are made in both chemically bonded and hard fired basic refractories of various compositions which are widely used with particular benefit in suspended roofs and walls in the several types of metallurgical furnaces.

STAR AND VEGA SILICA BRICK

These two superior silica brick now are made at seven widely separated Harbison-Walker Plants. Shipments from these advantageous locations provide important savings in transportation time and cost.

STAR brand is regarded as standard for refining furnace bottoms and roofs at many plants. It is used in reverberatory Matte smelting furnace roofs and in a number of electric smelting furnaces of different designs.

VEGA is the original super-duty high temperature silica brick from which greatest benefit is derived in vulnerable positions where extremely severe operating conditions prevail.

ALUMINUM FURNACE REFRACTORIES

Refractories which are best suited for use in aluminum melting and holding furnaces possess properties which meet various specific requirements. In some furnaces, the refractories in the bottoms are subjected to severe impact and abrasion. In the production of various alloys in accordance with certain rigid specifications, the refractories used must be such that any contamination, such as silicon pick-up, is avoided. High resistance to wetting and penetration by molten metal is paramount. In the operation of many aluminum melting furnaces, the refractories are required to withstand severe spalling conditions.

KORUNDAL

The unusual combination of desirable physical properties of this 90% alumina refractory, makes it particularly adapted for use in bottoms and lower side walls. KORUNDAL is very strong and resistant to mechanical abuse, penetration by molten aluminum and thermal spalling. This brand made in modifications, such as KORUNDAL DOT and KORUNDAL F fulfill various specific needs to greatest advantage.

H-W CORUNDUM

—is a 99%+ alumina refractory which is used in the linings of certain furnaces for melting pure aluminum, free from any contamination.

ALAMO

Along with other Harbison-Walker super-duty fireclay brick brands, ALAMO is favored for upper walls and roofs.

Harbison-Walker products for aluminum furnaces comprise several other high-alumina refractories, high-duty fireclay brick brands possessing the particular properties needed for best performance in this service. Also included are all the various classes of castables and other monolithic materials as well as high temperature bonding mortars especially suited for this requirement.

HARWACO BOND · THERMOLITH · KORUNDAL BONDING MORTAR

HARWACO BOND (diaspore base), THERMOLITH (chrome base) and KORUNDAL BONDING MORTAR (stabilized alumina base), cold-setting high temperature bonding mortars have unusually high strength for the temperature range of their use and are very resistant to wetting and penetration. While these may be used interchangeably for laying the various types of brick in aluminum melting furnaces, each provides special benefits, for particular sets of operating conditions.

REFRACTORIES

metallurgical operation

H-W MONOLITHIC MATERIAL

KORUNDAL RAMMING MIXTURE . H-W CHROME CASTABLE . . . H-W EXTRA STRENGTH CASTABLE AND H-W PLASTIC FIRE BRICK among the full complement of Harbison-Walker monolithic refractories are especially adapted for aluminum furnace requirements. They are favored in this industry because of the pronounced properties of volume stability, low thermal expansion and high resistance to both penetration and abrasion.

REFRACTORIES FOR OTHER NON-FERROUS METAL FURNACES

The service conditions in furnaces employed in the numerous non-ferrous metallurgical processes vary widely, and the refractories must meet highly specialized requirements. The selection of the proper refractory frequently governs the degree of success of the processes employed in the reduction, refining and melting of these metals. Harbison-Walker products comprise all the different types and classes of refractories needed for all the metallurgical processes, such as for the reduction and refining of nickel, lead, zinc, magnesium and other metals.

Extensive research and experience governs the selection of the particular Harbison-Walker refractories which serve best in metal chloride furnaces such as for making titanium and zirconium chlorides and for the production of metallic sodium and chlorine.

BASIC REFRACTORIES

The superior performance of Harbison-Walker basic refractories is the result of a thorough knowledge of the requirements, extensive and continuous original research conducted by the Harbison-Walker Research Department, and highest quality raw materials processed in modern plants under close laboratory control.

CHROMEX B

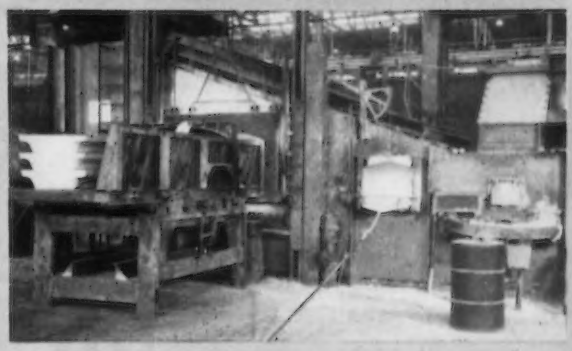
—an extremely hard fired chrome-magnesite refractory having unusual constancy of volume and strength at high temperatures.

METALKASE

—the pioneer metal-encased basic brick, possessing an unusual combination of desirable properties.

CHROMEX

—a chemically bonded chrome-magnesite brick having excellent spalling resistance.



MAGNEX

—a chemically bonded magnesite-chrome brick—highly basic and of low spalling tendency.

H-W MAGNESITE

—the standard burned magnesite refractory in various metallurgical industries for more than half a century.

THERMAG

—a hard burned magnesite-chrome refractory possessing enhanced physical properties.

H-W CHROME

—a hard burned chrome brick especially adapted for various specific uses.

FORSTERITE

—the only commercially produced magnesium-silicate brick—suited for certain particular applications.

H-W PERIKLASE

—an exceptionally high magnesia brick of unusual high-temperature stability.

OTHER BASIC REFRACTORIES

H-W Magnamix . . . H-W C-Mix . . . H-W Washington Dead Burned Magnesite Grains . . . H-W Washington Furnace Magnesite . . . H-W Special Furnace Chrome . . . Dry and Plastic Thermolith Batch . . . Thermolith and Other Cements . . . and Ramming Mixtures.

The outstanding records made by Harbison-Walker refractories are due to the most modern and efficient manufacturing facilities, the full complement of types and classes, and the high quality of the products.

Harbison-Walker's technical staff stands ready to assist in the selection and application of refractories that will serve dependably and economically.

Harbison-Walker Refractories Company
AND SUBSIDIARIES

General Offices . . . Pittsburgh 22, Pennsylvania

®

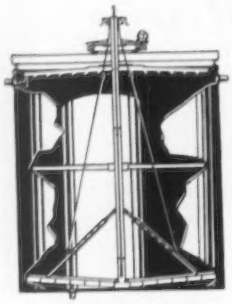
HARDINGE COMPANY, INCORPORATED

YORK, PENNSYLVANIA

NEW YORK • TORONTO • CHICAGO • HIBBING • HOUSTON • SALT LAKE CITY • SAN FRANCISCO

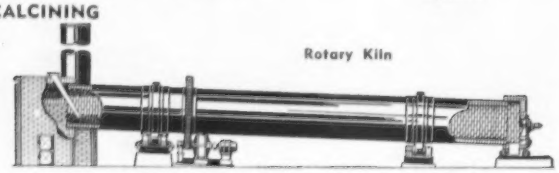
AGITATING

Hardinge combined mechanical and air Agitators are used to mix, agitate or store clay slurries, as well as metallurgical and chemical pulps. Compressed air is delivered to the bottom of the torque tube (which acts as an air lift) and to various points near the ends of the rotating scrapers. Pulp is fed and withdrawn continuously or intermittently, as desired. The drive mechanism is supported on ball bearings in an oil-filled, totally enclosed housing. The scraper raising winch is in easy reach and away from possible splash of pulp. Bulletin 31-E-1.



Agitator

CALCINING



Rotary Kiln

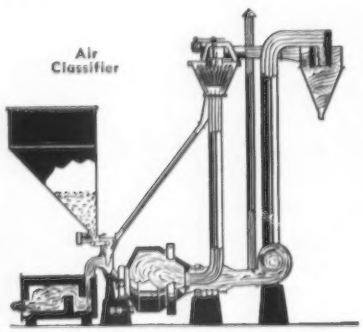
For small and medium capacity requirements, Hardinge offers the Ruggles-Coles Rotary Kiln for continuous calcining, roasting or oxidizing operations. It may be fired by oil, gas or pulverized coal. Bulletin 16-D-1.

Hardinge also makes a line of vertical shaft kilns, both direct-fired and mixed-feed types. The Keystone Lime Kiln is ideal for smaller operations using coal, coke, oil or gas for fuel. Bulletin 23-A-1.

CLASSIFYING • SEPARATING

Dry Classifiers

The Hardinge "Gyrotor" Air Classifier, operating in conjunction with the Hardinge Mill, is a compact, self-contained unit of unusual efficiency. The material is conveyed without auxiliary apparatus to any convenient location in the building. The Hardinge "Gyrotor" Air Classifier provides extremely close product control. Bulletin 17-C-1.



Air Classifier

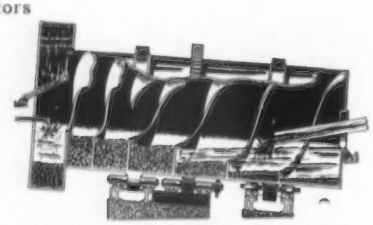
Wet Classifiers

The Hardinge Counter-Current Classifier is used for making size separations of ores and sands. It consists of a slowly rotating drum, on the inner surface of which is attached a screw flight. Will operate in closed circuit with a grinding mill without the use of conveyors or pumps. The Hardinge Hydro-Classifier is a large-volume classifier for fine separating problems. Bulletin 39-B-1.

Hydro-Classifier

Heavy Media Separators

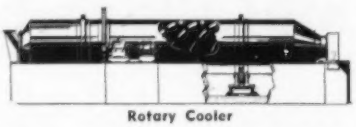
The Counter-Current unit is also used as a Heavy-Media Separator. The "Sink" is separated from the "Float" by the screw flights as shown. The unit has only one moving part, is very efficient and will start up fully loaded. Bulletin 39-B-1.



Counter-Current Classifier, Heavy-Media Separator

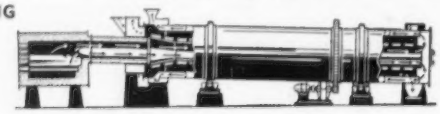
COOLING

Ruggles-Coles Rotary Coolers are employed for cooling hot materials after high temperature drying or calcination. There are three types: the air type, utilizing an induced cool air stream; the partially submerged type (illustrated); and the water spray type with exterior sprays cooling the shell. Bulletin 16-D-1.



Rotary Cooler

DRYING



Class XB Double-Shell Rotary Dryer

There are six distinct types of Ruggles-Coles double- and single-shell Rotary Dryers, designed for direct, indirect and steam heat. Bulletin 16-D-1.

Class XA — This double-shell, semi-direct-heat dryer has the highest thermal efficiency and lowest fuel consumption of any rotary dryer manufactured. Particularly adapted for coal drying.

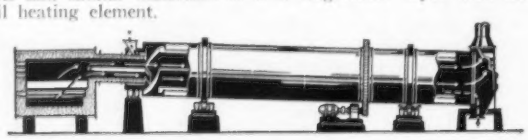
Class XB — A double-shell, indirect-heat dryer designed to handle such materials as kaolin, chalk, whiting, china clay, pigments, fuller's earth.

Class XC — A rotary steam tube dryer for drying materials that are injured by high temperature such as brewers' grain, cotton seed, starch feed, tobacco stems and corn germs.

Class XF — Single-Shell, counter-flow dryer for high drying temperatures.

Class XH — A single-shell, parallel-flow dryer, especially designed to handle flotation concentrates without sticking and without excessive dust loss.

Class XW — Used almost exclusively for drying inorganic salts and similar materials. It is a single-shell dryer with steam coil heating element.



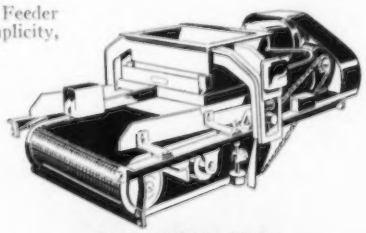
Class XH Single-Shell Rotary Dryer

FEEDING

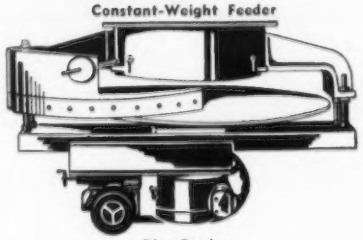
The Hardinge Constant-Weight Feeder measures by weight, not volume, thus compensating for variations due to changes in specific gravity, bulking or size of material. The feeder is quite accurate, and it affords automatic feed control for crushers, pulverizers, mixers, dryers, kilns, furnaces and conveyors. The feeder is bin-supported, requires little headroom. An indicating, totalizing or recording tachometer may be attached to the feeder drive to provide a weight measurement or record of the feeding operation.

The Hardinge Disc Feeder is outstanding in its simplicity, sturdiness and ease in adjustment. Particularly suitable for handling bulky, sticky, hot materials. Economical in cost and requires a minimum of headroom.

Other Hardinge regulating feeders are: the Volumetric Belt Feeder which provides uniform volume feeding control; and the Volumetric Non-Flooding Drum Feeders which employ the rotary pocket principle. Bulletin 33-E-1 describes the entire feeder line.



Constant-Weight Feeder



Disc Feeder

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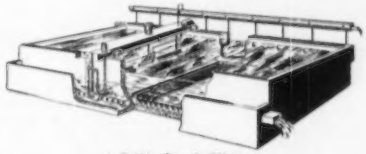
FILTERING

The Hardinge Automatic Backwash Rapid Sand Filter cleans its own filter bed, a section at a time, automatically, without shut-down or change-over. Primarily adapted to the filtering of water containing small amounts of suspended particles that cannot be properly collected in settling basins or clarifiers. Used for filtering municipal water supplies, industrial water supplies, and certain presettled industrial waste waters to permit their re-use. Bulletin 46-A-1.

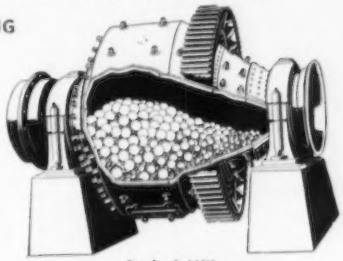


A.B.W. Sand Filter

GRINDING—PULVERIZING

Conical Mills

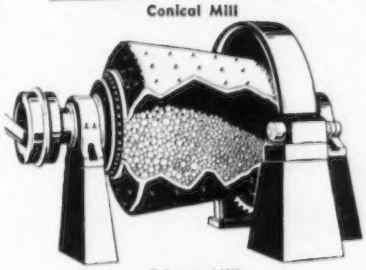
The shape of the Hardinge Conical Mill causes a rapid circulating and classifying action within the drum, which increases the capacity for power expended over other types. The range of grinding is large, due to the segregation of the sizes within the mill. Sizes range from 2 feet to 10 feet with capacities from a few pounds per hour to 100 tons per hour. Bulletin 17-C-1 gives dry grinding applications; Bulletin AH-389-1 wet grinding.



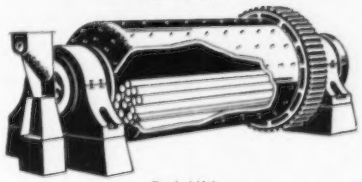
Conical Mill

Tricone Mills

Built on the same principle as the Conical Mill, the Tricone Mill offers greater grinding volume for a given amount of floor space than any other tumbling mill built. Extremely efficient. Ideal for large tonnages. Sizes up to 12 ft. diameter. Bulletin AH-414-1.



Tricone Mill



Rod Mill

Rod Mills

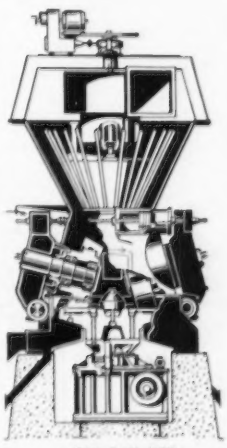
Steel rods are employed as grinding media. Ideal for producing minimum oversize in open circuit grinding. Convex or conical heads reduce friction, prevent congestion of charge at the ends, and align the rods. Available with either end, or center, peripheral discharge, as well as trunnion overflow. Bulletin 25-C-1.

Disc Roll Mills

An adaptation of the German "Loesche Mill." A roller mill with rotating grinding table and pneumatically-loaded rolls for complete flexibility of operation. The "Gyrotor" Classifier, combined with the Disc Roll Mill, provides a highly-efficient dry-grinding device, ideal for relatively soft minerals. Bulletin 52-1.

"Electric Ear"®

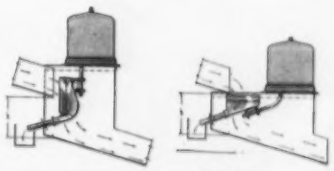
A revolutionary principle of control that automatically regulates the feed rate of a mill to keep it operating at maximum efficiency by "listening" to the sound. Mill capacity is increased 10% to 20%. Bulletin 42-A-1.



Disc-Roll Mill and "Gyrotor" Classifier

SAMPLING

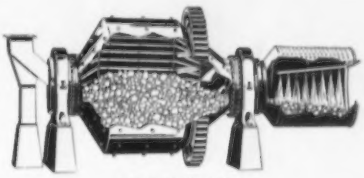
The Hardinge Automatic Sampler is simple in design, rugged in construction and offers a wide selection of sampling intervals and cutter openings. Accurate, continuous and trouble-free operation. Available for wet or dry processes. Wet models illustrated; type "A" cutter (left), type "B" (right). Bulletin 47-1.



Automatic Wet Samplers

SCRUBBING

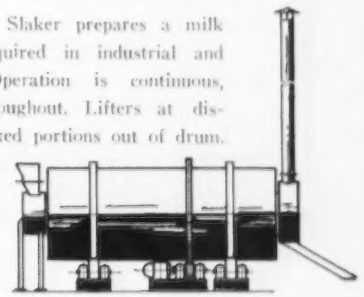
The Hardinge Conical Scrubber cleans by mass contact and natural displacement. This action removes dirt and silt without wear on the scrubber. The classifying action of the cone holds back the large clay balls until properly disintegrated. Foreign materials, such as sticks, vegetation or large pieces of metal, can do no harm. Power required is low, and water requirements are considerably less than that of other methods. Repair costs are negligible. Bulletin 37-B-1.



Conical Scrubber

SLAKING

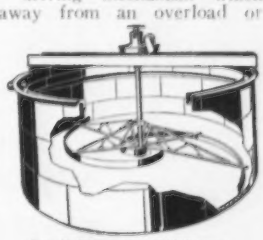
The Hardinge Lime Slaker prepares a milk of lime slurry as required in industrial and chemical processes. Operation is continuous, with close control throughout. Lifters at discharge end dump unslaked portions out of drum. Impurities and grit in the discharge can be separated by a Hydro-Classifier if desired. Bulletin 50-1.



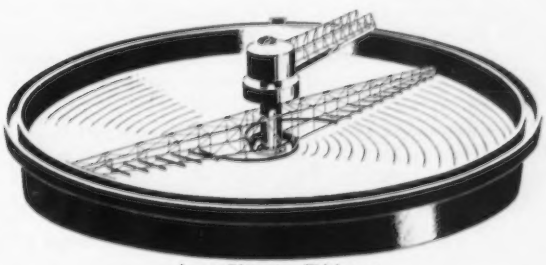
Lime Slaker

THICKENING

The distinctive features of the Hardinge Thickener are the spiral scrapers, which clean the bottom of the tank with each revolution, and the "Auto-Raise" driving mechanism which automatically lifts the scrapers away from an overload or obstruction in the tank bottom, thus eliminating costly breakdowns and delays. Can be operated very slowly, causing a minimum of disturbance. Produces a clearer overflow and a thicker discharge than other types. Small thickener mechanisms are supported on beams, spanning the tank. The large units carry the mechanism on a central concrete pier. Bulletin 31-E-1.



Small-Diameter Thickener



Large-Diameter Thickener

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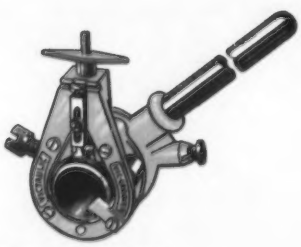

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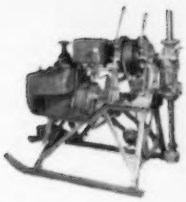

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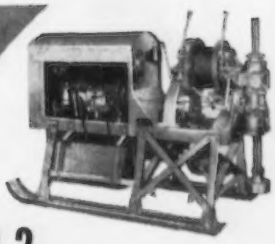
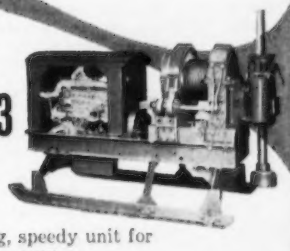


BBS-2

Versatile, choice of 5 swivelheads. Depths to 3,500 ft. Gas or diesel.

BBS-3



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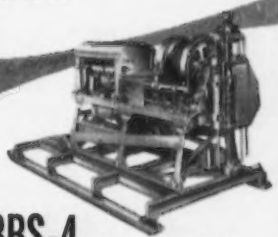

BBS-4

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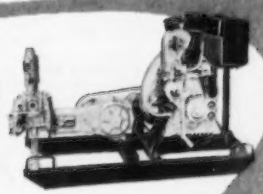
drill pumps



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Rugged. Capacity 1,800 ft. with "E" Rods, 1,400 ft. with "A", four gear speeds.

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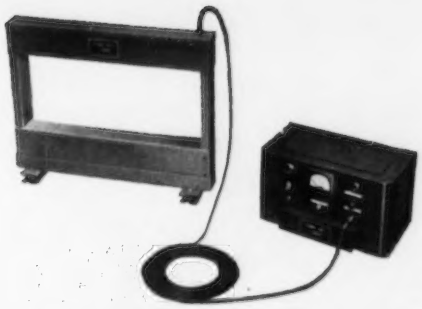


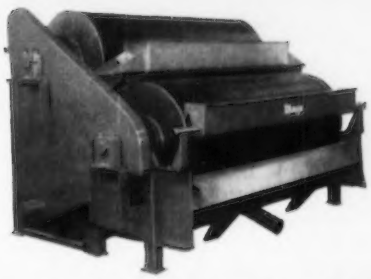
NEW DINGS METAL DETECTOR

Now . . . a positive, low-cost method for protecting valuable processing machinery against tramp metal damage. This simple, easily installed Detector will detect the presence of all magnetic metals — as well as weakly magnetics such as manganese — even in extremely deep burdens. Completely self-contained, with 30 feet of cable for remote control.

DINGS RECTANGULAR SUSPENDED MAGNET

For pulling iron from fastest belts, deepest burdens, here's the mightiest member of Dings force — RM models available to pull iron through 30 inch air gap. New Dings RM uses less current, weighs less in proportion to strength — Compact design takes less room, dissipates heat faster.

Remove Tramp Iron and Reduce Processing Costs with these 4 efficient DINGS PRODUCTS



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For maximum efficency and economy in all classes of heavy-media separation and direct concentration service, Dings offers a full line of wet drum magnetic separators to meet your specific requirements. Backed by over 50 years of specialized experience and proved performance.

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Powerful, air cooled electro magnetic pulleys are ideal for conveyor belts with heavy burdens. Installed as head drive pulley, tramp iron is discharged automatically. Low operating cost, long life and maximum range characterize this workhorse of the Dings line.

Dings *non-electric, self-energized* Perma Pulley magnets are recommended where burden depths do not exceed 3".

Dings

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GM155

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THE NEW BLAW-KNOX MUCKING BUCKET

These words of praise for this new bucket were by a man who has been in the shaft contracting business since 1900, Mr. Williamson went on to say—"It loads faster and has much more closing power. In addition to that, because of its balance and streamlining, I believe it is much safer to operate."

This bucket, operated on normally available 85 to 100 pounds air pressure, suspended by a single cable attached to a hold line socket at the head of the bucket. It is closed or opened by an attendant pulling one or the other of two chains attached to the walking beam type opening and closing valve. Available in ⅜ and ⅝ cubic yard sizes for stock shipment. For complete information contact your Blaw-Knox dealer.

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Blaw-Knox Equipment Division
PITTSBURGH 38, PA.

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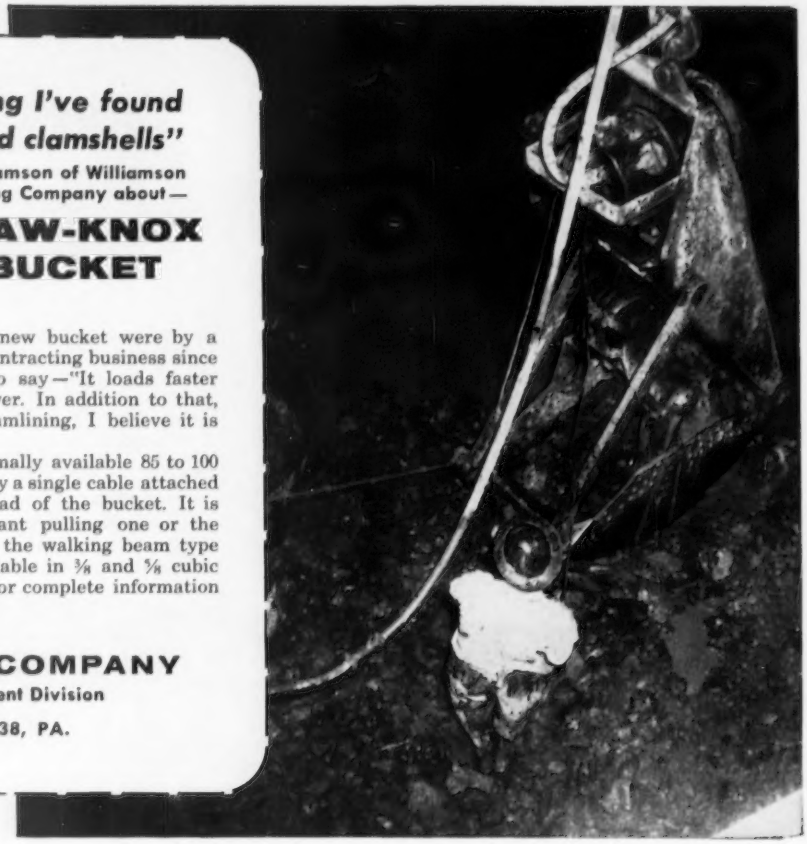
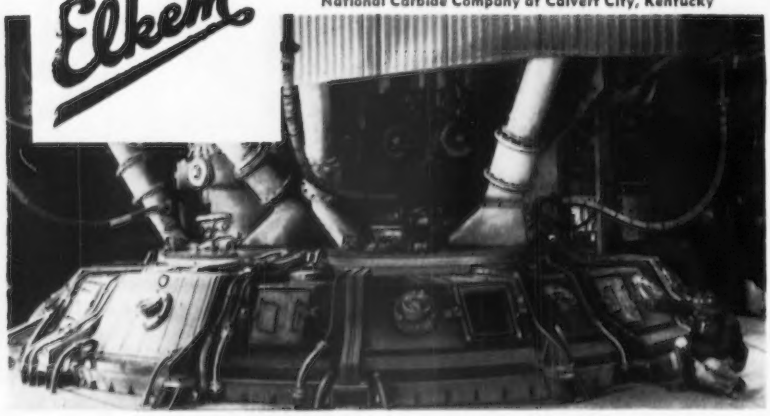


Elkem

Furnace Platform of 1 of 4-39,000 KVA ELKEM CALCIUM CARBIDE Furnaces installed by National Carbide Company at Calvert City, Kentucky



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For the production of: CALCIUM CARBIDE — FERRO ALLOYS — PIG IRON — COPPER MATTE — NICKEL MATTE — PHOSPHORUS etc. The Soderberg self-baking Electrodes for smelting, melting and aluminum furnaces.

In existence for over 50 years, Elektrokemisk has served as consultants and constructors of smelting plants and aluminum reduction cells.

Leaders in metallurgical plant design and erection, Elektrokemisk has introduced Soderberg self-baking electrodes and furnace construction in over 30 countries all over the globe.

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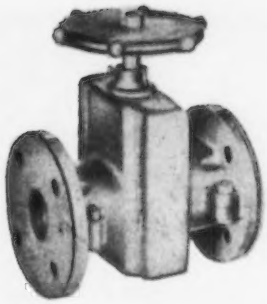

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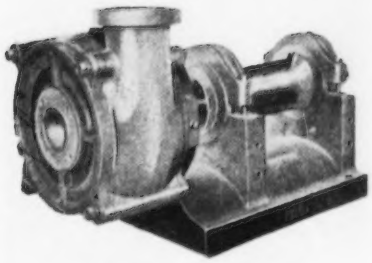

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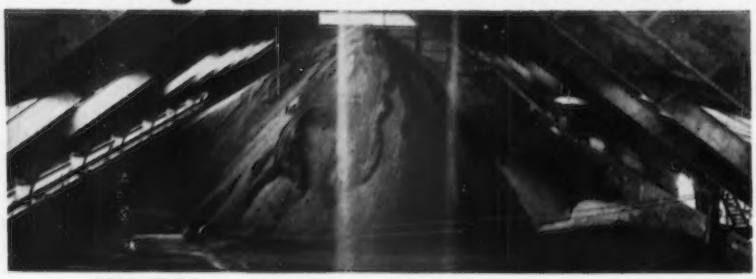
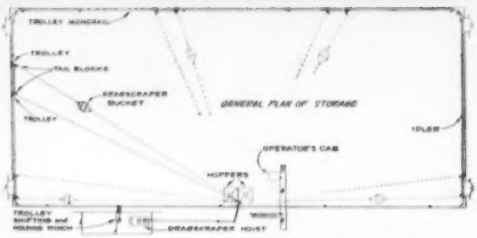
Three Sauerman Methods for Cutting Storage and Reclamation Costs

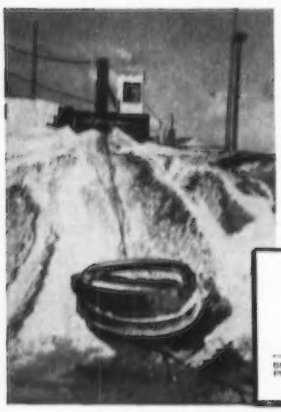


INDOOR RECLAMATION

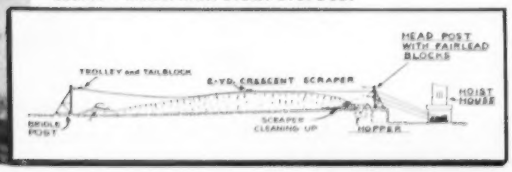


DragScraper with Trolley and Monorail—Material dropped onto stockpiles from an overhead conveyor is reclaimed to hoppers by a 2½-cu. yd. DragScraper. The installation uses a monorail and trolley system to permit shifting of the scraper bucket by remote control from operator's station at right.—*Sauerman News No. 143.*

OPEN STORAGE

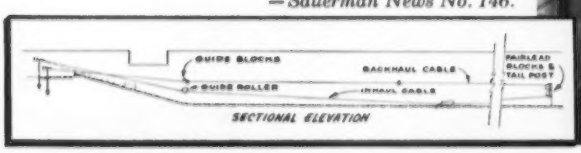


DragScraper with Trolley and Elevated Bridle—DragScraper is reclaiming raw potash to hopper from storage pile. Material is dumped at rear of the pile and moved closer to hopper during intervals when mill requirements are satisfied. Trolley and tail block travel on an elevated bridle between two stiff-leg bridle posts. Shifting of the trolley is provided by a third drum on the Sauerman DragScraper Hoist—*Sauerman News No. 146.*



HANDLING HOT MATERIAL

DragScraper—Hot scale is dropped from ingot buggy track into tunnel and is conveyed by DragScraper to a water sluiceway for disposal. Safety is important here—personnel and vulnerable equipment do not enter the hazardous area.
—*Sauerman News No. 146.*



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Give us details on your operation. Our engineers will give prompt recommendations and work with you to provide the best method for your requirements. Ask for Catalogs A (DragScrapers) and E (Bulk Storage by DragScraper).

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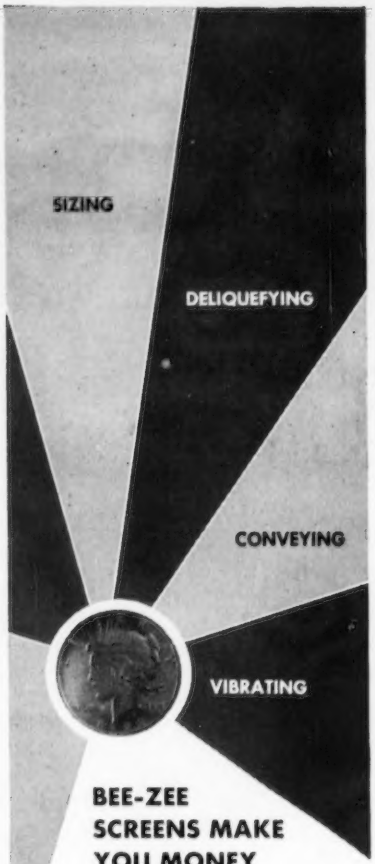

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ELECTRO-MAGNETIC PULLEY

Powerful Stearns electro-magnetic pulley effectively removes tramp iron from fast-flowing, heavily loaded conveyor lines. Solidly built, thoroughly insulated and protected. Special, new thin-coat drum lagging increases tractive effort without affecting magnetic pull. Sizes range from 12-inch diameter units to world's largest. Bulletin 303-D.

MAGNETIC EQUIPMENT

tailored to the mining industry

Stearns Magnetic Products builds a complete line of magnetic separation equipment to meet the specific requirements of both metallic and non-metallic mining operations. Equipment includes electro-magnetic pulleys, heavy media separators, cross-belt separators, suspended separation magnets, as well as special high-intensity magnetic equipment designed especially for mineral separation.

Stearns' experienced engineers work directly with you in designing and installing magnetic equipment that is engineered to fit your individual operating needs exactly.

In addition, the company maintains a fully-equipped laboratory for thoroughly analyzing and testing ore samples. Requests for analysis or information receive immediate attention. We welcome your inquiry.

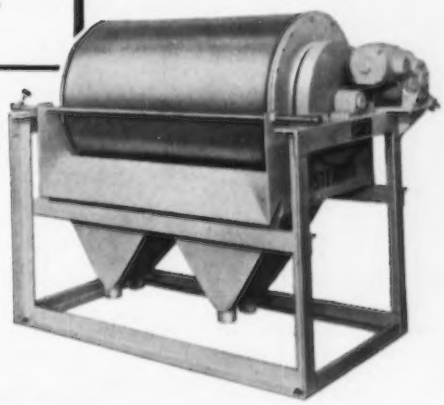
SUSPENDED SEPARATION MAGNET

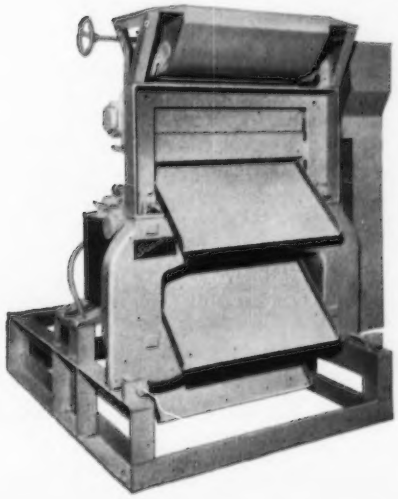
Provides a tremendous pulling force that reaches far down into material on conveyor lines — prevents escape of deeply embedded tramp iron. Coil-wound for continuous duty. Special insulation and rib-type head casting assures fast heat dissipation. Round or rectangular construction. Bulletin 88.

WET-DRUM SEPARATOR FOR TACONITE CONCENTRATION

The new Stearns Type WPD magnetic separator is a powerful wet-drum permanent magnet unit designed for cobbing and roughing in taconite concentrations.

Specially designed magnet has a deep, powerful field, and provides correct flux distribution for positive transport of the collected magnetics to the discharge point. These and many other special features put the WPD separator in a class by itself for fast, low-cost taconite recovery. Bulletin 87.





TYPE K HIGH-INTENSITY GRAVITY INDUCTION MAGNETIC SEPARATOR

Stearns Type K magnetic separator provides an intensely powerful magnetic field which attracts very feebly magnetic particles. That is why the "K" has proved highly successful in purifying and concentrating chemical products when other methods were either impractical or inadequate.

Users report that this separator has given outstanding results for magnetically cleaning or concentrating materials ranging in size from 10 to 200 mesh. Capacity ranges from 80 to over 500 lb per hr per inch of feed width. "K" separators are built in 10, 20 and 30-in. feed widths and can be furnished from 2 to 7 magnetic fields. Bulletin 701B.

43

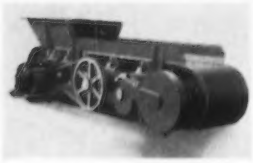
STEARNS MAGNETIC PRODUCTS

635 South 28th Street • Milwaukee 46, Wisconsin

Your Guide To Profitable Milling Operations

Morse Bros. Milling Equipment Designed

and Tested Through 59 Years of Experience

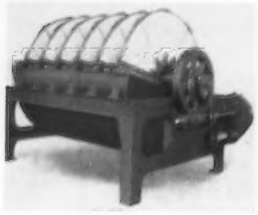


MORSE SILENT "VARI-STROKE" ORE FEEDERS

are extremely flexible in capacity, dependable in performance, and noticeably quiet in operation. They excel for feeding dry or wet crushed ore in uniform and predetermined quantities from ore bins to grinding machinery—belt speeds are variable from 0" to 7' per minute. Belt movement is precisely controlled at all times. Can be furnished for attachment to the channel iron frame. **Request Bulletin # 469.**

MORSE BALL MILLS

are made in 30", 3', and 4' diameters. Trunnion bearings are of sufficient diameter to accommodate long shells for rod and tube mill service. The trunnion bearings are the solid type. The 3' and 4' mills have three (3) bearing countershafts with sole-plates for lateral adjustment of gears. Scoop or combination drum and scoop feeders can be furnished. The wave type head and shell liners are made of hard-iron, molychrome or manganese steel. **Request Bulletin # 475.**



MORSE "CONTINUOUS" DISC FILTERS

offer advantages over other types as they require less floor space per ton of material treated, and have the ability to filter concentrates and different materials simultaneously. The sizes range from 4 feet to 8 feet in diameter and up to 8 discs having 22 to 800 square feet of filter area. **Request Bulletin #4710.**

MORSE "TRUELINE" CLASSIFIERS

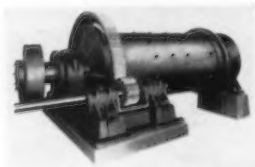
are mechanically correct, metallurgically efficient, low in maintenance cost, and require only minimum headroom. All bearings have fittings for standard pressure lubrication. Machine-cut gears with guards are standard, and are factors in giving smooth mechanical performance. The rake movement is positive, and in a straight "TRUELINE" parallel with the tank bottom. The maximum amount of sands are discharged as a result of the "TRUELINE" movement. **Request Bulletin #447.**

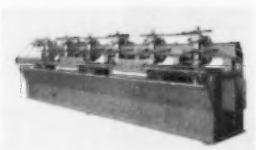
MORSE CONDITIONERS

are ruggedly constructed with low head super-structures; furnished with redwood, welded or bolted steel tanks. The shaft is mounted into a one-piece bearing housing containing two Timken tapered roller bearings. **Request Bulletin #B45.**

MORSE DRUM FILTERS

are highly regarded universally for efficiency and dependability in general filtering and dewatering problems. They are fully automatic, continuous in operation, have a wide range of applications, and are manufactured in sizes from 3 to 8 feet in diameter, having filter areas from 9 to 350 square feet. **Request Bulletin #4710.**





MORSE "JETAIR" FLOTATION CELLS

are manufactured in sizes ranging in volume from seven to one hundred cu. ft. per cell. They are supplied with weir gate pulp level controls for each individual cell and incorporate new principles of aeration and agitation that are approved universally for metallurgical efficiency and mechanical dependability. **Request Bulletin #482.**

MORSE DIAPHRAGM PUMPS

are made in two, three and four-inch sizes, and in simplex and duplex styles for belt or gear-motor drive, and for mounting on the thickener super-structure or on separate foundations. **Request Bulletin #B45.**

←MORSE ROD MILLS

are made in sizes of 3' and 4' diameters and up to 11' in length. Ideal for grinding coarse feeds to as fine as 65 mesh. The heavy construction of these mills has proved itself in years of dependable service. **Request Bulletin #475R.**

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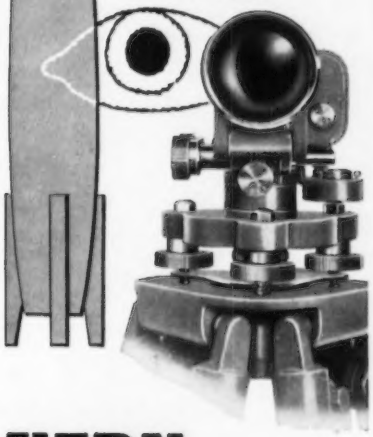

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Why Getman Brothers Picked AIRCOOLED DEUTZ DIESELS to power its ore carrier

The Scoot Crete Ore Carrier serves in underground and open-pit mining, carrying loads up to 3500 lbs. and climbing 25° grades. A fast-starting Diesel, with no over-heating problems, high fuel efficiency and minimum down time was called for. The answer was a DEUTZ AIRCOOLED DIESEL.

In picking a DEUTZ AIRCOOLED DIESEL, Getman Brothers joins Longyear, Atlas-Copco and a long list of other American and foreign manufacturers in specifying the world's outstanding aircooled diesel for their equipment. Only DEUTZ has these outstanding features:

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- Top running capacity at temperatures ranging from −40° to +140° F.
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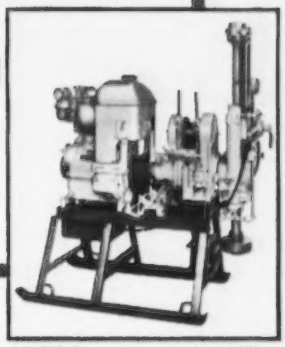
- Complete service and parts facilities right where you need them

Manufacturers, dealers and operators are invited to send for a detailed illustrated catalog featuring performance data and specifications.

Dealerships in some areas still open



LONGYEAR mineral exploratory drilling machine with Deutz Aircooled Diesel Engine Unit uses Longyear Diamond Core Drill #24. Longyear selected Deutz for its compactness of design, fuel efficiency and excellent service and parts facilities.

Mine installation at Rock Springs, Arizona, uses ATLAS COPCO Compressor CT-6 with Deutz–6 cylinder A 6L/514 engine to assure top running efficiency in all temperatures. The semi-portable compressor provides 320 C.F.M.

PARTIAL SPECIFICATIONS TABLE

Model	Cont. BHP/Cont. RPM
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F 2 L 612	20/2000
F 3 L 612	30/2000
F 4 L 612	40/2000
F 6 L 612	60/2000
A/F 2 L 514	30/1600
A/F 3 L 514	45/1600
A 4 L 514	60/1800
A 6 L 514/614	90/1800
A 8 L 614	120/1800
A 12 L 614	180/1800

Also a full range of automotive engines with 4, 6, 8 and 12 cylinders operating at 2300 RPM.

DEUTZ

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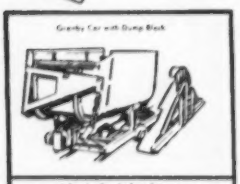
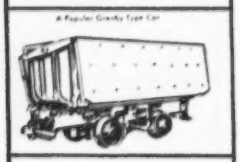
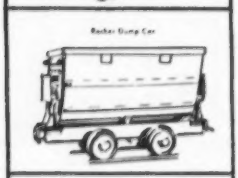
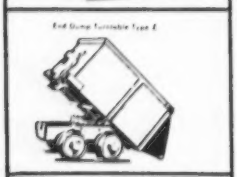




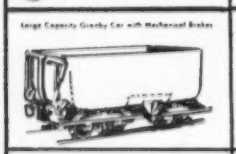


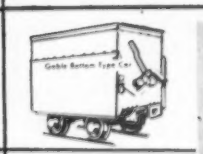


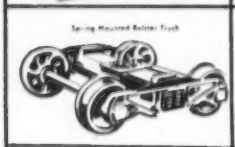
Our shops are known to mining men throughout the world for custom building of mine cars and other haulage equipment. Here are some of the standard and custom designed items made by Card. For complete information, write or phone.

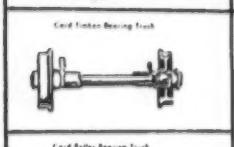
Frequently modification of a standard Card car will serve to meet every specification of special haulage at very little more than the cost of a standard car. Our engineers can show you how to standardize your mine haulage with cars that are custom built for you alone. Many mine operators find they cannot afford even to make car bodies and repair parts...Card prices are lower even after freight costs are added.

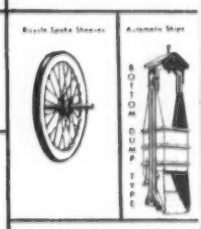
**Be your production large or small,
Card can fit your needs—economically.
Our engineers are available for consultation
on your haulage problem. No obligation.**

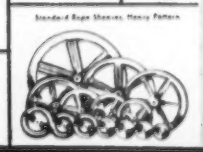












- Coal Mine Cars
- Ore and Industrial Cars
- Mine Car Wheels & Trucks
- Sheaves—Rope, Knuckle, Curve
- Track Rope Rollers, Slope Rollers
- Carrying Sheaves, Swivels, Hitchings
- Loading Booms, Landing Chairs
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C.S. Card Iron Works Co.

2501 WEST 16TH AVE.
DENVER, COLORADO

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Be sure to check through pages 19-31 of this Guidebook for the latest developments in:

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More From Drillhole Samples
Reducing Vibration
Mud Fluids for Tough Jobs
Drill Types and Applications
How Much Drilling Water
Beating Overburden Problems

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Minerals Conductivity
Electromagnetic Methods
Airborne Magnetometers
Radioactivity Detection
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Manufacturers advertising in this issue appear in bold-faced type. You'll find more useful information in their advertisements.

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EXPLOSIVES RESEARCH PAYS OFF

Excellent breakage of iron ore from primary blasts assures speedy, economical loading operations.

An uninterrupted cycle of production in a mine begins with the selection and use of the right explosives and blasting method.

A continuous research and development program at Hercules makes explosives available for all kinds and conditions of work . . . in mines and quarries, on heavy-construction jobs, on seismic exploration projects.

Hercules sales engineers welcome the opportunity to consult with you on your explosives and blasting requirements and to assist in finding satisfactory solutions to your problems.

HERCULES

HERCULES POWDER COMPANY
INCORPORATED
Explosives Department, 933 King St., Wilmington 99, Del.

X857-1

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CUT BLAST HOLE COSTS

with **PORTADRILL** Model 6TA

LOWER INITIAL COST
FASTER PENETRATION
FASTER MOVING
LESS MANPOWER
LOWER COST OPERATIONS

Fully unitized, the 6TA is a tractor mounted rotary drill utilizing compressed air for cuttings removal. All power is furnished thru tractor engine. Completes 9″ diameter holes to all blast hole depths.

DRILLS UP TO 3′ PER MINUTE

Faster drilling cuts costs! Up to 27,000 pounds pressure on bits gives penetration speeds up to 3′ per minute in average drilling including shales, limestones, sandstone and other hard formations.

PUT THE 6TA to work! Low initial cost, lower operational costs, faster moving that gives more drilling time, less manpower for efficient operations combine to give lower cost, faster blast hole operations.

COMPLETE DETAILS ON REQUEST

PORTADRILL
REG. U.S. PAT. OFF.

Ask for complete Specifications Bulletin 6TA

MANUFACTURED BY
WINTER-WEISS CO.
2201 Blake St., Denver 5, Colo., U.S.A.

Portadrill Models include conventional drills; "air blast" and combination air-water and Reverse circulation models—truck, tractor or trailer mounted for vertical hole operations to 2,000′ depths and up to 60″ diameters.

Are You Seeking New Ideas On METALLURGY?

Be sure to check through pages 82-123 of this Guidebook for the latest developments in:

- Flotation Machines
- Minerals Separation
- Solids-Gas Contacting
- Solvent Extraction
- Agglomeration
- Pelletizing
- Dust Collecting
- Cyclones and Filters

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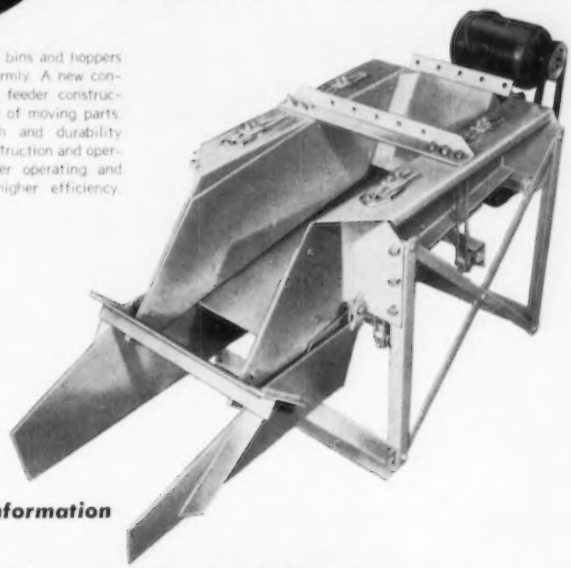
NICO

RECIPROCATING PLATE FEEDER

For use under chutes, bins and hoppers to feed material uniformly. A new concept in reciprocating feeder construction, with a minimum of moving parts. It combines strength and durability with simplicity of construction and operation, to obtain lower operating and maintenance costs, higher efficiency.



For further information write

NATIONAL IRON COMPANY

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The NICO Model 500-C

The NICO Model 500-C employs four doubled flexible steel cables to suspend the reciprocating plate, eliminating the most troublesome parts of ordinary feeders of this type. Cable bending permits the plate to swing freely with no binding or wearing.

- **No rollers to lubricate**
- **No rollers to wear**
- **No track to keep clean**
- **No rollers to replace**
- **No track to wear**
- **No rollers to stick**
- **No track to replace**

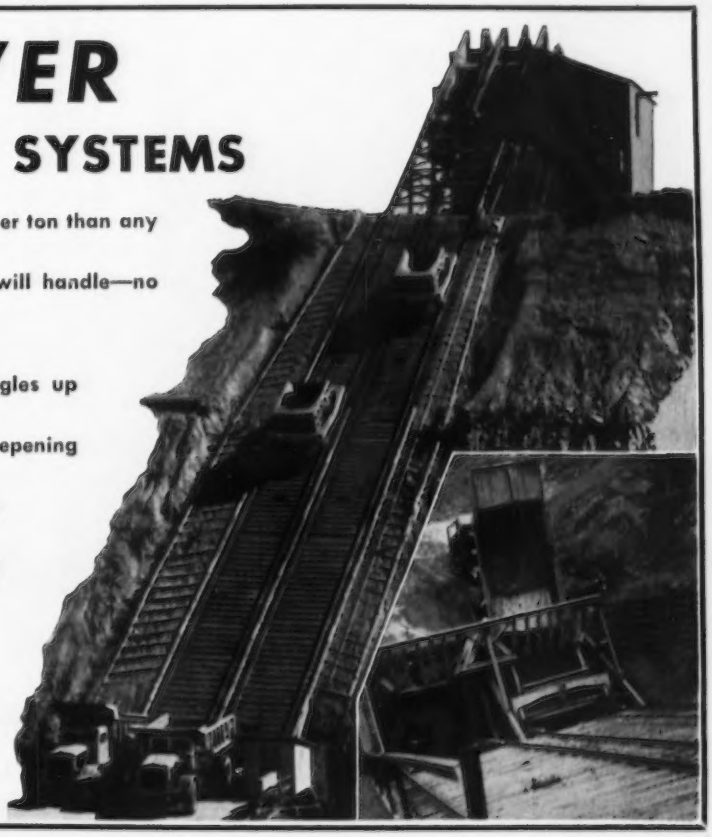
The Model 500-C cables do not need lubrication or cleaning. They cannot stick, and they last almost indefinitely. They are easily adjustable to change plate height, or angle of inclination of the plate when desired.

ROCKOVER

OPEN PIT SKIP SYSTEMS

- **Will elevate material at a lower cost per ton than any other system.**
- **Handle anything shovels and trucks will handle—no material too abrasive or blocky.**
- **Use only a few trucks in the pit.**
- **Track laid directly on pit wall at angles up to 45°.**
- **Simple extension of track follows deepening of pit.**
- **Load directly from trucks in pit. (See inset photo)**
- **Use multiple loading stations along trackway if desired.**

Skips of from 5 - 35 ton capacities available. Write for information.



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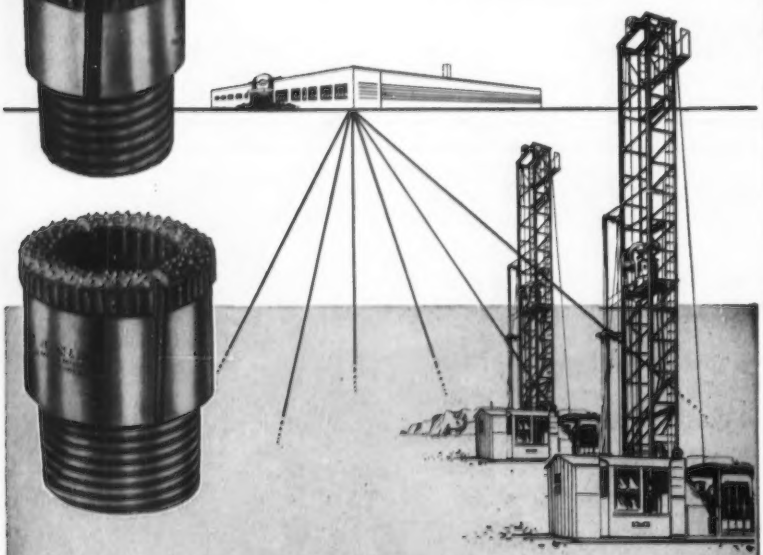
out of the factory into the ground . .

and a champion every foot of the way

J. K. Smit Diamond Drill Bits are designed and engineered in our own plant, and manufactured with one purpose in mind: to give you maximum cutting speed, plus the most economical footage under any possible hole conditions.

Problem	Solution
Non-abrasive formations	HARDHED matrix
Average drilling conditions	HARDHED 40 matrix
Extremely abrasive formations	HARDHED 55 matrix



In addition, experienced personnel are at your service for consultation on any phase of diamond drilling.

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PREPACKAGED MEALS

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The answer to your feeding problems for field personnel. Only firm in United States to offer this specialized food engineering and packaging service. All rations prepared and packaged to meet particular requirements of users. Used by big construction and oil companies, exploration parties, and others. Home-style American meals, with or without "comfort" items. Let us tell you how well we can serve YOU.

FEATURES
Units to feed two, four or more men. Tasty, wholesome, easily prepared meals. Widely varied menus. Long guaranteed shelf life. Waterproof packing materials. Full vitamin value per U. S. Standard. Caloric value 2500-6000 per man/day. Complete feeding or individual meals.

Wire, phone or write for free illustrated catalog.

Bolton Farm Packing Co., Inc.
P. O. BOX 66 NEWTON 64, MASS.

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E&MJ's MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all E&MJ subscribers.

Here's the easy, cost-saving way to remove Clinker Rings—

Remington Industrial Gun

WITHSTANDS HIGH TEMPERATURES AT KILN HOOD. Special steels and castings enable the Remington Industrial Gun to operate safely at kiln hood temperatures. Gun is easily installed by attaching bolster to hood I-Beam or movable mount as shown.

You save valuable man-hours in removing clinker rings with the hard-hitting Remington Industrial Gun. A pull of the gun's lanyard does the work of many sledge hammers... brings rings and other troublesome kiln formations down in minutes!

No need to wait until kiln cools off. In fact, you don't have to turn off flame or stop rotation until you're ready to shoot. Then just load . . . aim at ring juncture and BAM—the 9,000 ft.-lbs. of knockdown power from a Remington Industrial Magnum* shell smash into the ring! It takes only a short time to dislodge it—without damage to kiln or lining—and you're quickly back on full-time schedule.

Here's proof: One Georgia refractory saved 222 man-hours and gained 26 hours' production time per month with this easy-to-use, one-man tool. So don't let clinker rings "bottleneck" your plant, let the Remington Industrial Gun cut downtime to a minimum. Just clip and mail coupon for our illustrated, fact-filled folder.

** For shorter kilns, Remington Standard Industrial Shells fill the bill. 7,500 ft.-lbs. of energy are delivered!*

Remington

DUPONT

Remington also manufactures the Model 455 and "Mighty-Mite" Stud Drivers for instant fastening into concrete or steel.

Industrial Sales Division E.M.J.-6
Remington Arms Company, Inc.
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Please send me your free booklet which shows how the Remington Industrial Gun speeds removal of clinker rings.

Name_____ Position_____

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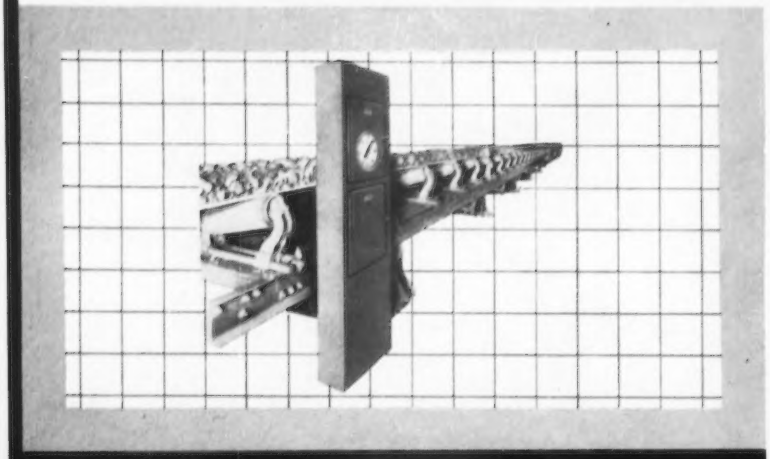
COSTS DOWN! PRODUCTION UP!



. . . WITH BUILDERS *Conveyoflo*

CONVEYOFLO® Meter is a precision unit of rugged construction for accurate totalization of all belt-conveyed materials. With the addition of a controller, a preset rate of delivery will be maintained. With the addition of a pneumatic transmitter, it can pace proportionally the delivery from auxiliary feeders in automatic processing systems. Conveyoflo comes as a complete unit including conveyor, drive, and weighing mechanism . . . or can be installed in your present conveyor lines. Here is thoroughly reliable, service-proven equipment.

FEATURES

- ACCURACY — within plus or minus 0.4 of 1% of full scale load over a 10:1 range.
- CONTINUOUS INTEGRATION — automatically compensates for variations in belt speed . . . provides accurate response to rapid load variations.
- OVERLOAD PROTECTION — weighing element and calibration not subject to damage by overloading.
- PNEUMATIC OPERATION — inherently explosion-proof.
- COMPACT — weight sensing mechanism completely contained within conveyor structure. Panel located above or below conveyor as desired.

ACT TODAY!

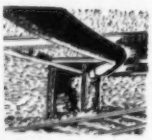
Bulletin 550-H4A gives complete data on Conveyoflo operation, accuracy, totalizer head, weigh spans, etc. Request your copy from **Builders-Providence, Inc.,** 391 Harris Ave., Providence, R. I. . . . division of

BUILDERS-PROVIDENCE
DIVISION OF
B-I-F INDUSTRIES (B-I-F METERS FEEDERS CONTROLS)

THE OUTSTANDING MINE VENTILATION LINE

Outstanding
- ✓ FOR QUALITY
- ✓ FOR DEPENDABILITY
- ✓ FOR COMPLETENESS

ABC FLEXIBLE VENTILATION TUBING



NEOLON TUBING

The new Neoprene coated Nylon fabric tubing. Almost impossible to tear. Airtight Resistant to abrasion, acid mine water and flexing. Same lengths and diameters as MineVent.

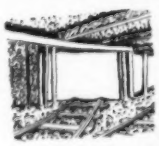
MineVent TUBING

Jute base, synthetic rubber coated. Resists leakage, abrasion and moisture. Available in 9 diameters, 8" to 36" and 25, 50 or 100 ft. lengths. Choice of 2 types of suspension, demountable patented Snap-On coupling or Sewed-In coupling. Most widely used mine ventilation tubing.

NON-COLLAPSIBLE TUBING

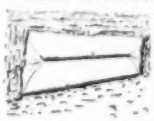
Both MineVent and Neolon are available with telescoping spring wire inserts rendering the tubing non-collapsible. Light weight. Economical.

ABC BRATTICE CLOTH



7 types to fit all needs —3 types of jute cloth, 2 types of cotton, plastic, and Black Ace for nongaseous mines. Carefully processed to resist flame except Black Ace, and to resist mildew. In widths and lengths for any seam.

ABC INFLATABLE BRATTICE



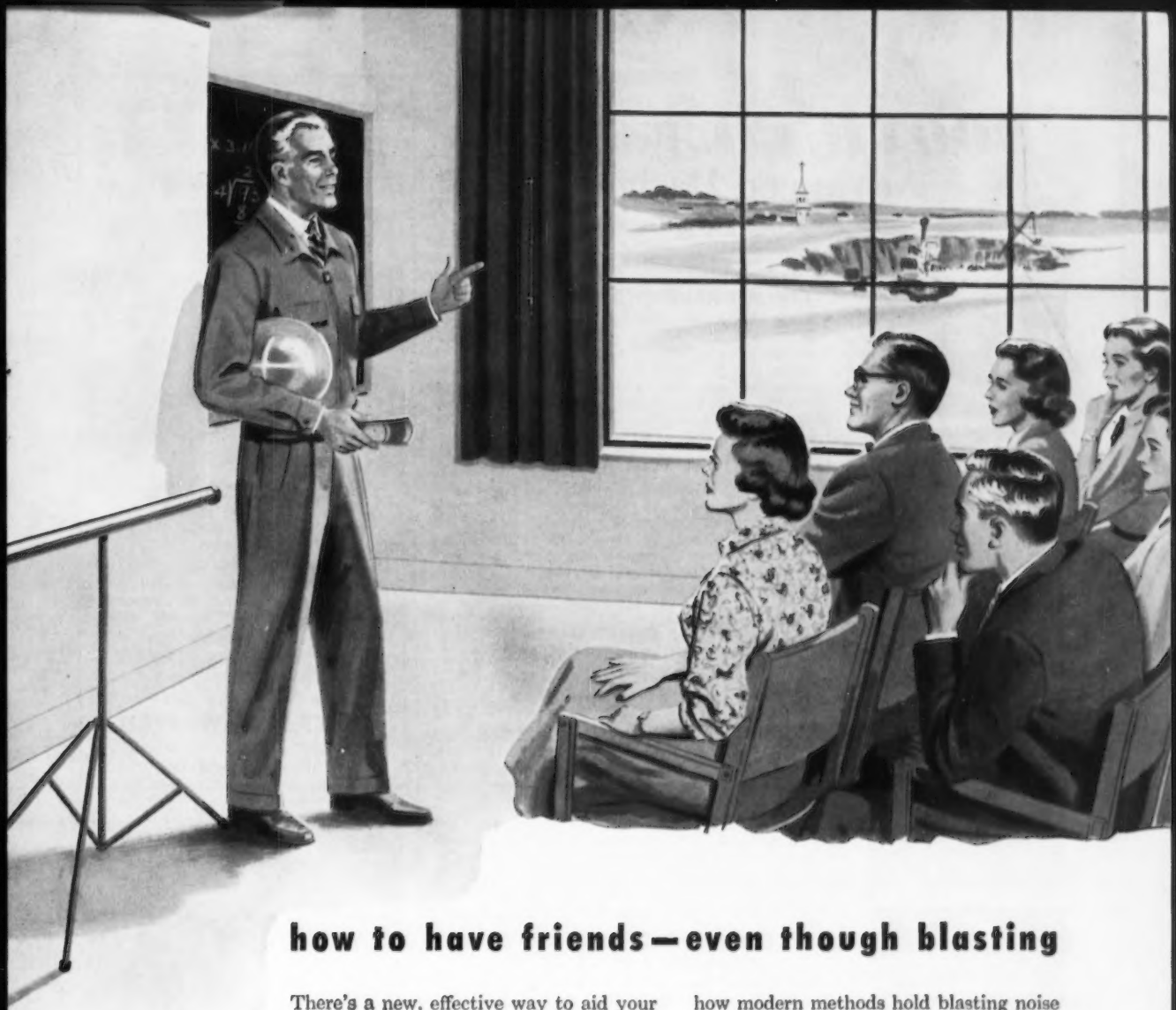
Sizes to fit any opening. Readily fills rough contours, jagged walls, etc. Quickly inflated by special hand pump. Quickly deflated to move to new location. Easy to transport. Economical to use.

ABC POWDER BAGS

Rubber coated durable fabric, firmly sewed, for long use and hard wear. 6 sizes: 20, 25, 30, 60, 125 and 160 sticks of explosive.

Send for Catalog 57.

AMERICAN BRATTICE CLOTH CORP.
WARSAW, INDIANA
220 So. Buffalo St., Warsaw, Indiana



how to have friends—even though blasting

There's a new, effective way to aid your public relations in communities where you are blasting. It's the interesting, informative sound film, in color, entitled, "*We're Blasting Near You.*"

When you show this film to PTA meetings, service clubs and other civic organizations, you can prove that you're a good neighbor . . . that blasting, while necessary, is nothing for people to be alarmed about.

"*We're Blasting Near You*" shows how modern millisecond delay techniques eliminate old-fashioned, jarring explosions . . . how modern methods hold blasting noise to a muffled minimum, and make vibration unnoticeable. In a friendly, noncommercial way, the movie shows your efforts to be a good citizen in the community.

You can show this movie to any age group. It is accompanied by a kit containing news releases, sample speeches, safety posters and other helpful material which will make your public relations meeting a success. Write for available dates, and show "*We're Blasting Near You*" in your community!

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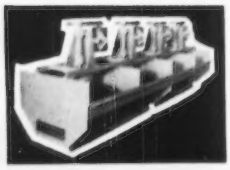
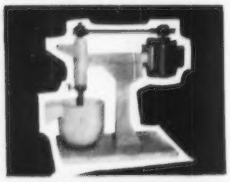
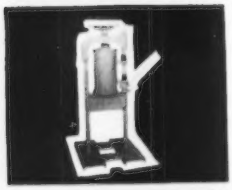
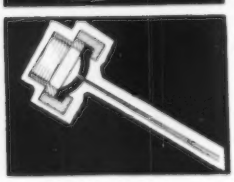
BOOTH CO. Products of Advanced Design

for the Mining Industry









COMMERCIAL FLOTATION MACHINES

Seven sizes of agitation type flotation machines are available with many features to improve metallurgy and lower operating costs, including thorough circulation with vigorous pulp movement throughout cell, more intense aeration than any other agitation type machine, better selectivity with less reagent consumption, complete utilization of cell volume, easy froth removal, and extremely durable wear parts. Bulletin No. 561

LABORATORY FLOTATION MACHINE

The aerating mechanism is carefully proportioned to represent a scale-down of the commercial size flotation machine. Flotation data can be directly interpolated into plant requirement estimation for BOOTH flotation machines. This machine is very easy to operate and clean, thus minimizing the testing engineer's time. All wear parts are corrosion and abrasion resistant. Bulletin No. 562

RUBBER COVERED AND SOLID RUBBER IMPELLERS

Five sizes of rubber covered cast iron impellers, and seven sizes of solid rubber impellers are available to meet the requirements of almost any agitation service where corrosion and abrasion are a problem. Both types can also be furnished in neoprene. Bulletin No. 563

ORE TESTING AND ENGINEERING SERVICES

The BOOTH Company maintains a fully equipped ore testing laboratory and a competent staff of metallurgical, chemical, and mechanical engineers with experience in almost any type of ore to aid in solving your mineral beneficiation or chemical engineering problem. Bulletin No. 564

LABORATORY ROLLS AND INFRA-RED SAMPLE DRYER

The compact, versatile, combination laboratory rolls for ball mills and bottles featuring quick speed change is available with rubber covered rollers from 25 to 48 inches long. Fast, thorough drying of metallurgical samples is yours with a BOOTH Infra-red Sample Dryer. Bulletin No. 565

PRESSURE SAMPLE FILTER AND LABORATORY BALL MILL

The BOOTH Sample Filter and Laboratory Ball Mill are both unexcelled for speed and convenience. Barrel and yoke of filter close from open position quickly and easily and line up automatically. Sealing is accomplished by rotating a single handwheel. Ball mill cover is centered automatically and sealed by a single nut. Bulletin No. 566

NON CLOG SPRAY

The only spray ever developed for flotation plants. Can effect a reduction in plant launder spray water consumption of 40% to 60%. Durable rubber diaphragm automatically ejects any foreign material without flow interruption. Bulletin No. 571

"40 Years of Ore Treatment"

The **BOOTH** *Company inc.*

333 WEST 14th SOUTH • SALT LAKE CITY, UTAH

Mineral Separation • Research • Equipment • Plant Operation

RIBLET

AERIAL TRAMWAYS

Reduce Transportation Costs!

Modern Riblet Aerial Tramways provide low cost hauling for minerals, wastes and other products over any terrain.

They run in straight lines over roads, rivers, swamps & valleys in all kinds of weather.

Write Dept. F-2 for Brochure

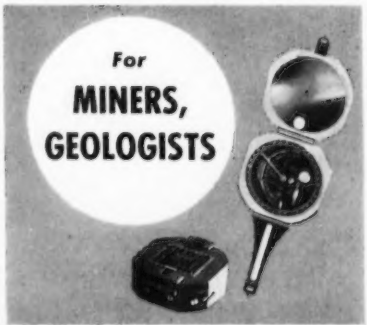
RIBLET TRAMWAY CO.

Box 7, Sta. A. Spokane, Washington

Since 1894

For

MINERS, GEOLOGISTS



THE BRUNTON* POCKET TRANSIT

IT'S HANDY...

weighs only 9 oz.; 2¾" x 3" x 1⅛"; easy to carry in pocket, on belt, in car.

IT'S VERSATILE...

ideal for preliminary and supplementary surveying; used as a compass, transit, level, plumb, alidade, clinometer.

IT'S MADE TO LAST A LIFETIME

Shows direction to 1°; level, slope or grade within 1°.

"Over 60,000 Brunton Transits since 1896"

See your local engineering supply house or WRITE FOR CATALOG

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POIDOMETERS for . . . .

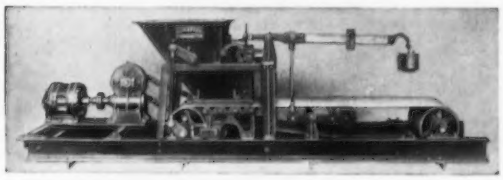
WEIGHING • CONVEYING • PROPORTIONING • BLENDING • FEEDING • MIXING

The Schaffer Poidometer is an accurate, durable machine for weighing, feeding and conveying raw materials used in mining, milling, smelting, refining and concentrating industries. Automatic and always dependable, it handles all crushed, granular and pulverized matter.

Proportioning by weight is a function to which the Poidometer is particularly well adapted. In a wide range of applications, batteries of Poidometers regulate and facilitate blending and mixing processes, at the same time keeping an accurate, centralized record of the amounts of materials handled.

SIZE		MAXIMUM CAPACITY*		Maximum Size of Cubes	Available With Motor Operated Gate
Belt Width	Length Scale Platform	Light Duty	Heavy Duty		
6"	2' 0"	2 Tons		Finely ground	No
10"	2' 6"	5 Tons		Finely ground	No
	4' 6" & 6' 0"		12 Tons	Finely ground	No
14"	2' 6"	8 Tons		½" Cubes	No
	4' 6" & 6' 0"		24 Tons	½" Cubes	No
20"	2' 6"	15 Tons		1½" Cubes	No
	4' 6" & 6' 0"		60 Tons	1½" Cubes	Yes
30"	4' 6" & 6' 0"		158 Tons	3" Cubes	Yes
36"	4' 6" & 6' 0"		220 Tons	4" Cubes	Yes
48"	4' 6" & 6' 0"		300 Tons	4½" Cubes	Yes

* Figured on material weighing 100 lbs. per cubic foot. Amount shown is capacity per hour.



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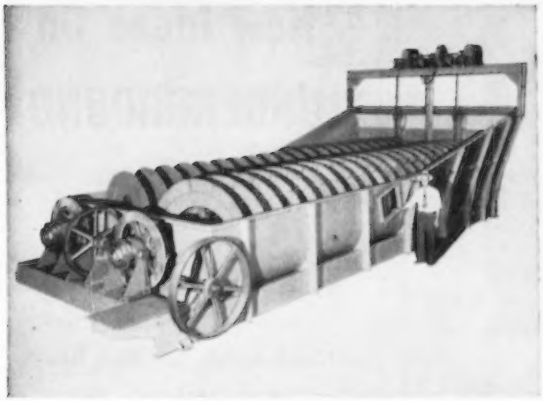

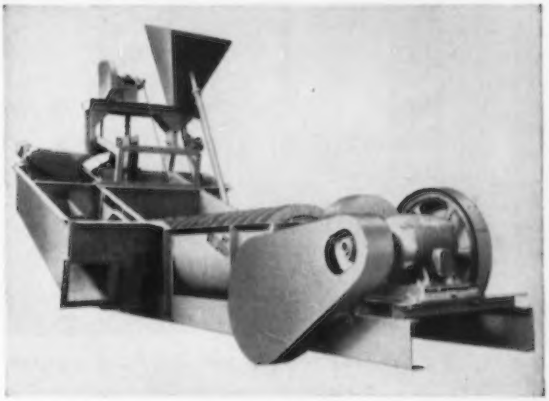

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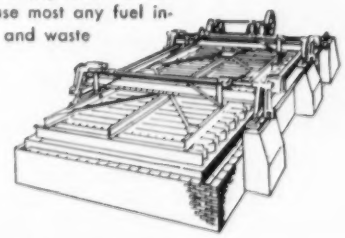

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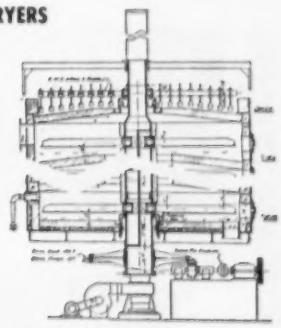

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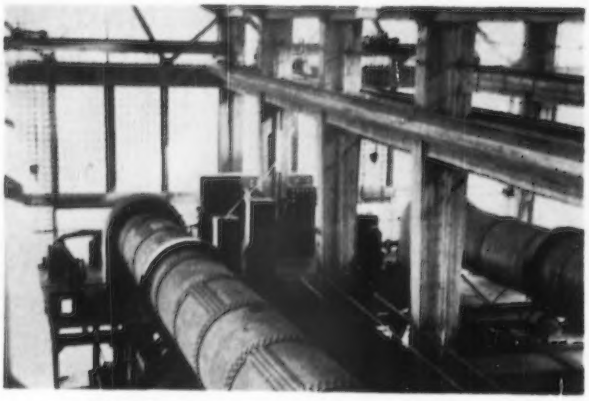

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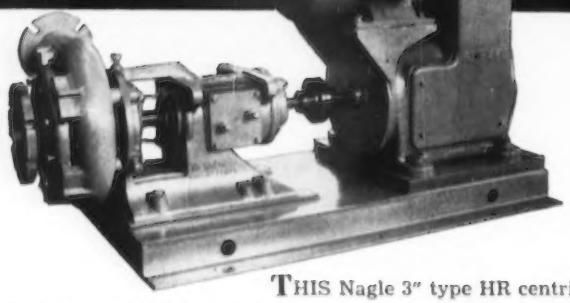

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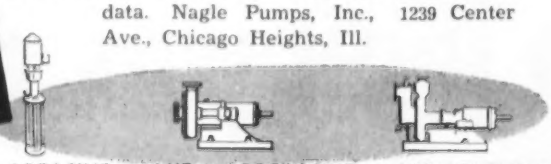

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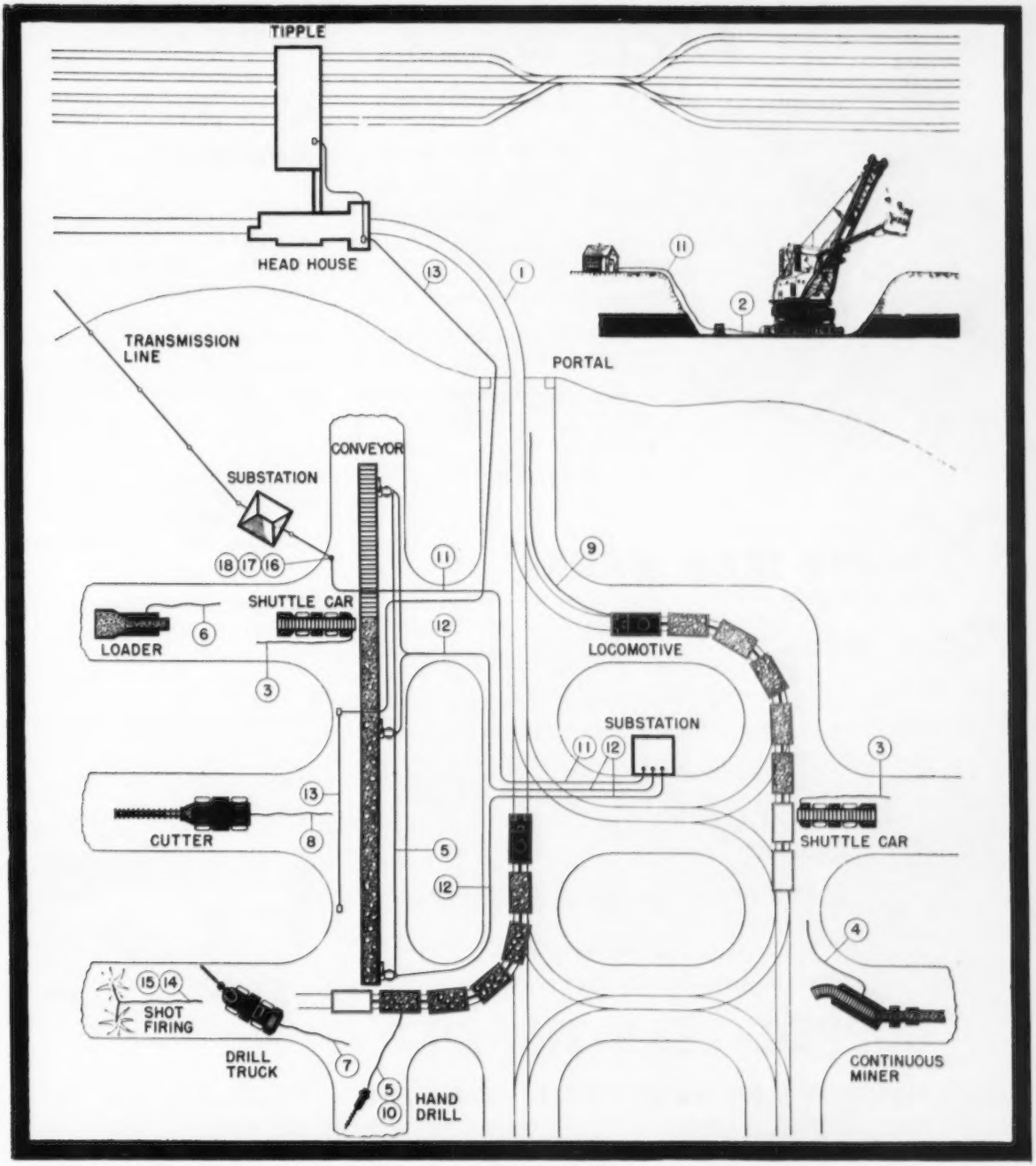

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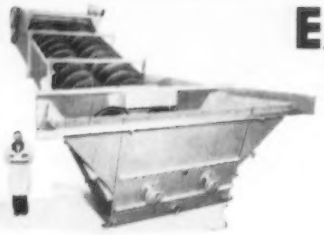

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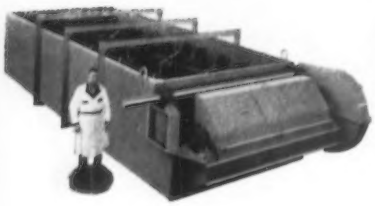

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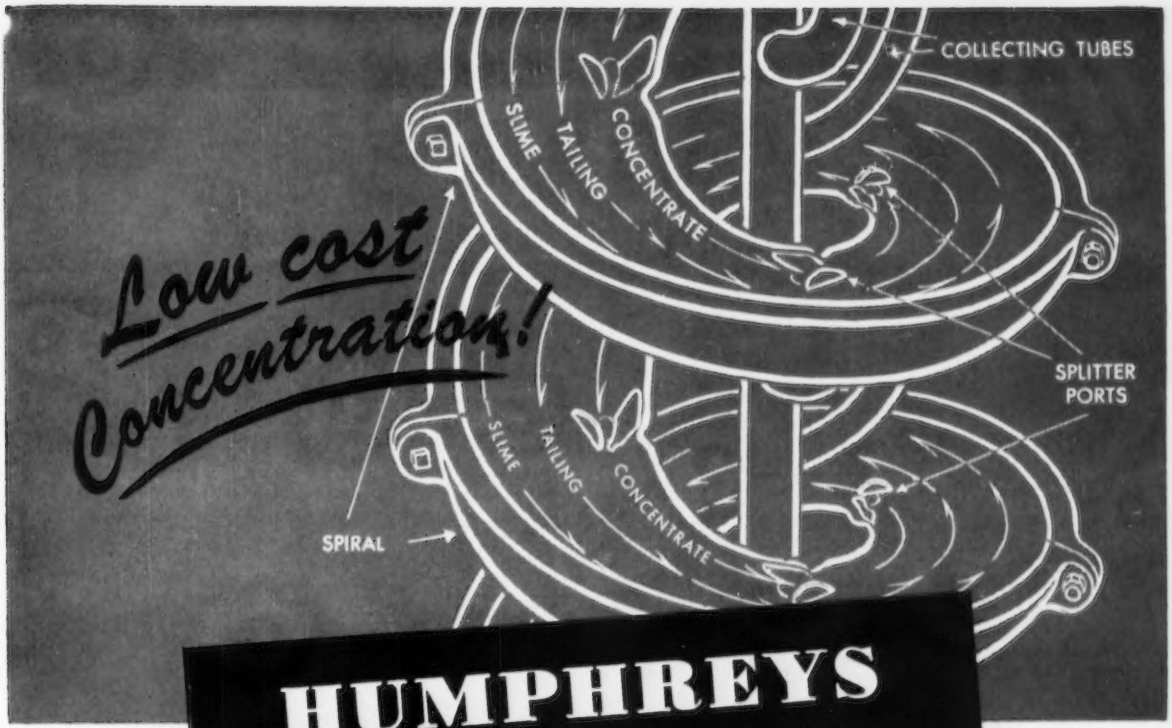

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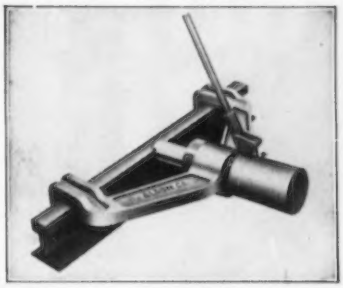

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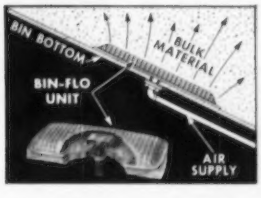

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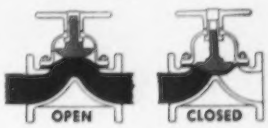

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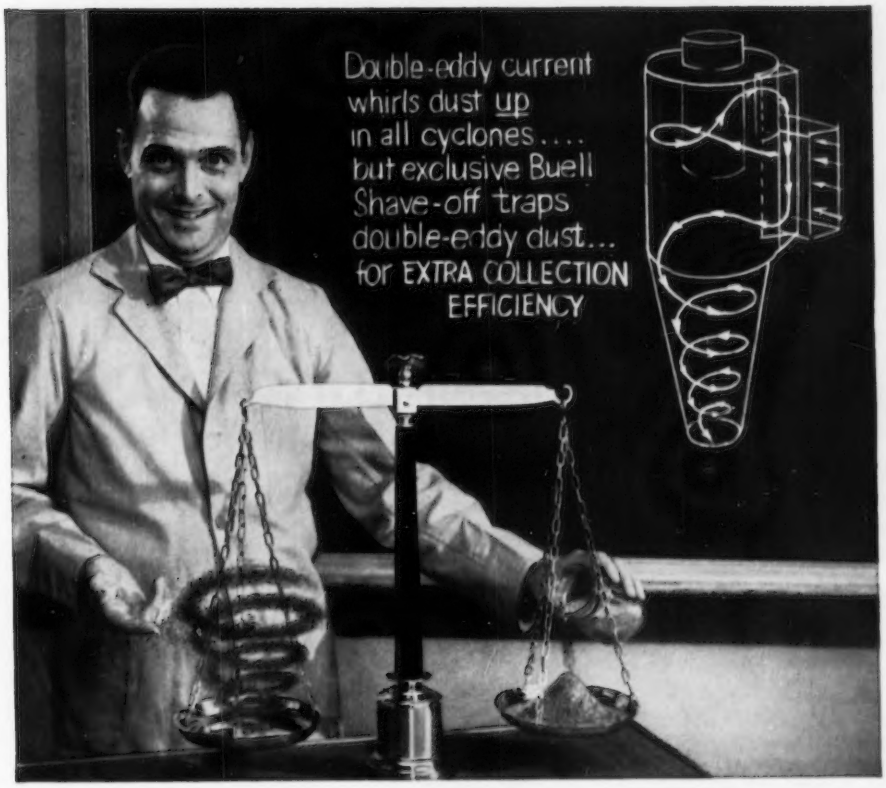
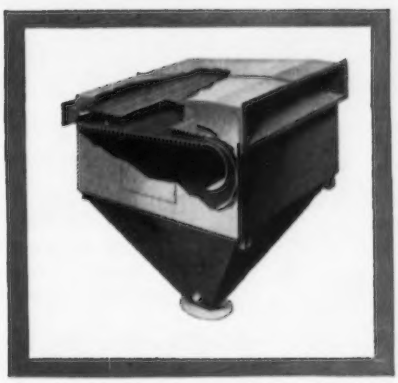
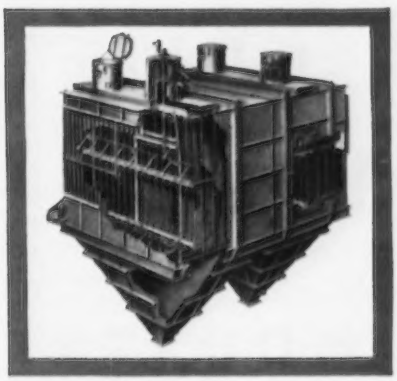


Side entry of dust-laden gases through Buell-designed manifolds minimizes turbulence, raises efficiency even higher in Buell cyclones. Large-diameter design eliminates clogging and bridging. Heavy plate construction assures years and years of extra service life without repair or replacement.



Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for either natural or mechanical draft installations. Ideal for boilers from 100 to 2000 BHP.



SF Electric Precipitator, a Buell exclusive, also delivers *extra efficiency* due to unique Spiralectrodes and Continuous Cycle Rapping of collecting electrodes.

For more specific data about Buell's *extra efficiency*, write Dept. EMJ-57 Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

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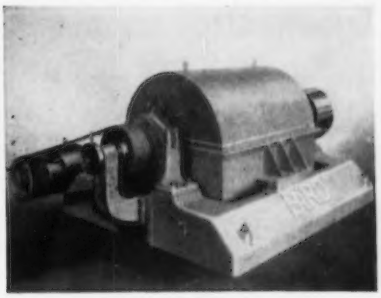

BIRD CONTINUOUS CENTRIFUGAL FILTERS

Designed especially for dewatering settleable coarse or fine solids to low moisture content. Feed slurry can be thick or thin, hot or cold. Operation is completely housed. Separation is by centrifugal sedimentation without use of filter media.

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Designed especially for sharp classification, or desliming, of solids finer than 325 mesh. Will function efficiently with slurries of relatively high solids content, and fine fraction can thus be filtered without re-thickening.

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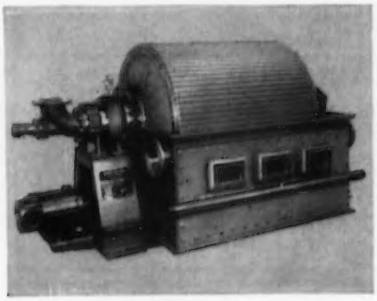
Designed especially for dewatering relatively coarse materials. Features high capacity, low moisture, and low solids loss in filtrate; exceptionally low power requirements, and long screen life; practically no degradation.



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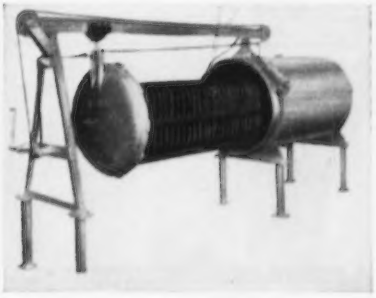
Designed especially for dewatering and washing operations. Will handle very free filtering and difficult to discharge materials. Permits sharp wash separation, complete cake discharge without mechanical devices. No tank agitation required.



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FOUR-POINT CROSS TYPE ROK-BIT

STANDARD STYLE

*CUTAWAY STYLE
H also designated as 116M
D also designated as 119D

BIT SIZE	THREAD DESIGNS AVAILABLE												
1 ¼"	A				112	113							
1 ⅜"		F			112	113							
1 ½"		F	H			113	115		Type 0				#200
1 ⅝"		F	H			113	115		Type 0				#200
1 ¾"			H	D			115		Type 0	Type 1			#200
1 ⅞"			H	D			115	118		Type 1			#200
2"			H	D			115	118		Type 1	Type 2		#200
2 ⅛"			H	D			115	118			Type 2		#200
2 ¼"			H	D			115	118	121		Type 2	Type 3	#200
2 ⅜"				D				118	121		Type 2	Type 3	
2 ½"				D				118	121		Type 2	Type 3	
2 ⅝"				D				118	121		Type 2	Type 3	
2 ¾"				D				118	121		Type 2	Type 3	
3"				D				118	121		Type 2	Type 3	
3 ¼"				D				118	121			Type 3	

CHISEL TYPE

Other threads on special order

BIT SIZE	THREAD DESIGNS AVAILABLE		
1 ½"	F	H	
1 ⅝"	F	H	
1 ¾"		H	D
1 ⅞"		H	D
2"		H	D
2 ⅛"			D
2 ¼"			D

"X" TYPE
(for long hole drilling)

BIT SIZE	THREAD DESIGNS AVAILABLE		
1 ⅞"	#400		
2"	#400		
2 ⅛"	#400		
2 ¼"	#400		
2 ⅜"	#400		
2 ½"	#400	#600	
2 ¾"		#600	
3"		#600	
3 ½"		#600 K	J7.5
4"		#600 K	J7.5
4 ½"			J7.5

CROSS TYPE
(for long hole drilling)

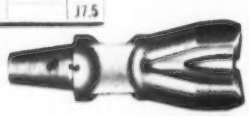
BIT SIZE	THREAD DESIGNS AVAILABLE	
2 ¾"	#600	
3"	#600	
3 ½"	#600	J7.5
4"	#600	J7.5

TAPER TYPE

Brass Shim Furnished with Each Bit

BIT SIZE	TAPER SOCKETS AVAILABLE		
1 ¼"	No. 7	'A'	
1 ⅜"	No. 7	'A'	
1 ½"	No. 7	'A'	
1 ⅝"	No. 8		'B'
1 ¾"	No. 8		'B'

ROK-MASTER ROK-BIT



HOLE-MASTER ROK-BIT

BIT SIZE	THREAD DESIGNS AVAILABLE	
6"	2" x 3" No. 7 A.P.I. Thread	For use with "QuarryMaster drill"
6"	Spline	For use with "Down the Hole drill"
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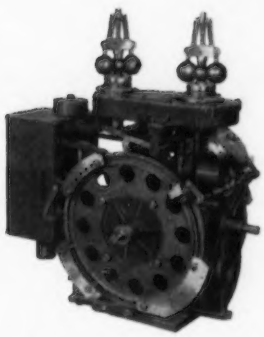
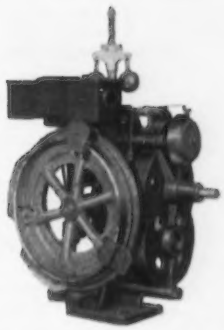


A MODEL C LILLY HOIST CONTROLLER with Duplex Governors. Model C Controllers are particularly suited to large and fast hoists. (See Catalog C-44)

A SIMPLEX HOIST CONTROLLER equipped with Depth Indicator and mounted on a Weight Unit with Regulating Cylinder for operating the brakes of small hoists. These units are best suited to small or relatively low speed hoists. (See Catalog S-46)



A MODEL D LILLY HOIST CONTROLLER assembled left hand. Model D Controllers are particularly suited to small or medium size hoists. (See Catalog D-44)

LOGAN HOIST RECORDER for recording all movements and delays of the hoist, and to provide a graphic picture of the manner in which it is operated. (See Catalog 447)

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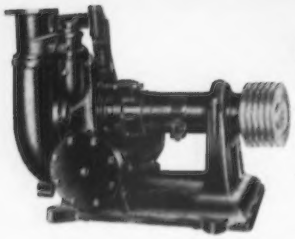
To the men of the Bureau of Mines, the Geological Survey and the Atomic Energy Commission;

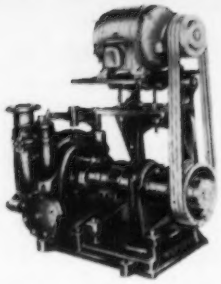
To the mining schools and technical consultants;

The editors of *Engineering and Mining Journal* are deeply grateful for their generous contributions of knowledge, experience and material. Through interviews and field trips by the dozen, and through letters and questionnaires by the hundreds, their advice and cooperation have been the backbone of this Guidebook.

WILFLEY centrifugal PUMPS



CENTRIFUGAL WILFLEY PUMPS ®



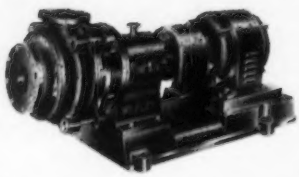
The new patented **WILFLEY MODEL "K"** centrifugal sand pumps are designed for maintained high efficiency in rugged service and trouble-free operation. They combine the original WILFLEY principles with new improvements developed through years of engineering experience.

BELT DRIVEN, overhead V-belt driven and direct driven WILFLEY Model "K" pumps available in 1", 1½", 2", 2½", 3", 4", 5", 6", and 8" discharge sizes with capacities to 3000 GPM and heads as high as 200'.

WILFLEY SAND PUMPS may be fitted with interchangeable electric furnace alloy iron or rubber covered wear parts to best meet the requirements of each pumping installation. The WILFLEY wear part design is ideal for rubber covering as ample clearance around the runner assures a practical and dependable rubber lined pump. Wherever you have a solids transfer job specify the WILFLEY Model "K" sand pump—for continuous, trouble-free performance, simple installation and stepped-up production.

Wilfley Sand Pump
"COMPANIONS IN ECONOMICAL OPERATION"
Wilfley Acid Pump

For Acids, Corrosives, Hot Liquids & Mild Abrasives



The new **WILFLEY MODEL "AF"** acid pump is famous for efficiency and dependability. Actual production-line records show worthwhile dollar savings in stepped-up performance and low-cost operation. Every day, in modern chemical plants the world over, WILFLEY Acid Pumps move hard-to-handle solutions on a trouble-free, round-the-clock schedule. Available in 5 to 2,000 GPM capacities with heads from 15 to 200' and higher.

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Individual engineering on every installation

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E&MJ's Buying Directory—1957

THE FOLLOWING PAGES were compiled by the editors of *E&MJ* to help you do your job more efficiently and profitably through the use of modern equipment and services.

The Buying Directory is divided into three major sections:

1. **Classification of Products**
2. **Manufacturers' Index**
3. **District Sales Offices of Advertisers**

Classification of Products. The first section of the Buying Directory contains thousands of listings and company names to help you find the product or service you want quickly and easily. Questionnaires were mailed to more than 2,000 firms which produce equipment or services to the mining industry and they indicated which items they wished to offer.

The editors have listed nearly every major product and service used in the mining industry and the companies which supply them. As an added service, cross-indexed headings are also included to speed up your use of the Directory.

Manufacturers' Index. The second section of the Directory lists, in alphabetical order, the manufacturers whose company names appear in the Classification of Products, along with their full mailing address.

You can get more information about a given product or service by checking the advertisement page numbers which also appear in the Manufacturers Index. These pages contain information which could not be included in the classification listing, but which the manufacturer wants you to have. Advertisers are indicated in each of the first two sections by bold face capital letters. Page numbers are listed only in the second section.

District Sales Offices. A new addition to the Buying Directory this year is the listing of district sales offices of the advertisers in this issue. It is included for your convenience in getting more information about a given product or service and for the purchase of equipment through the handiest source.

If you're planning a new project or just revamping an old one, or purchasing modern equipment, you can get the most out of the Buying Directory.

Check the product classification for the manufacturing or service company which will answer your needs.

If the company name appears in bold face, the Manufacturers' Index will give you not only the address of the company, but the page on which that firm's ad appears in this issue. Check the ad for more information about the product. And, if you're interested in an advertiser's product, you'll find the listing of district sales offices very convenient. Main office addresses appear in the section as well.

If the name appears in light face type, you may obtain the address from the Manufacturers' Index.

1. Classification of Products ►

A

ABRASIVES—also see: Carbides; Diamonds

Aluminum Co. of America
American Coldset Corp.
Chicago Wheel & Mfg. Co.
Diamond Drill Carbon Co.
Electro Refractories & Abrasives Corp.
Exolon Co.
HOFFMAN BROS. DRILLING CO.
Macklin Co.
Minnesota Mining & Mfg. Co.
Norton Co.
Pettinos, Inc., George F.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Simonds Worden White Co.

(ACETYLENE GENERATORS—see Gas Generators)

AERATORS

BIN-DICATOR CO.
BOOTH CO.
Cochrane Corp.
Graver Water Conditioning Co.
Infilco, Inc.
Jeffrey Mfg. Co.
Link-Belt Co. Dept. EMJ-57
Penberthy Mfg. Co.

(AERIAL EXPLORATION SERVICE—see Contractors)

AERIAL TRAMWAYS & CABLEWAYS—also see Excavators, Dragline Tower

Lidgerwood Industries, Inc.
Machinery Center Inc.
NORDBERG MFG. CO.
RIBLET TRAMWAY CO.
SAUERMAN BROS., INC.
Skookum Co., Inc.
Superior-Lidgerwood-Mundy Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Yara Engineering Corp. Interstate Equipment Div.

(AGGLOMERATING EQUIPMENT & SUPPLIES—see: Nodulizing, Sintering; Water Clarification)

Abbe Engineering Co.
Branford Co.
Christian Engineers, J. D.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Dwight-Lloyd Div. McDowell Co., Inc.
Fisher Scientific Co.
General American Transportation Corp.
LINK-BELT CO. DEPT. EMJ-57
Mead Mill Co.
Patterson Foundry & Machine Co.
Process Engineering, Inc.

AGITATORS & MIXERS, GAS

Turbo-Mixer Div. General American Transportation Corp.

AGITATORS & MIXERS, LIQUIDS & SLURRIES—also see: Flotation Machines; Scrubbers

Abbe' Engineering Co.
Atlantic Tank Corp.
Bethlehem Foundry & Machine Co.
Binks Mfg. Co.
BOOTH CO.
Canadian Locomotive Co., Ltd.
Christian Engineers, J. D.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Dorr Oliver, Inc.
Fisher Scientific Co.
GALIGHER CO.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
Infilco, Inc.
Moran Engineering Co.
MORSE BROS. MACHINERY CO.
Ogden Iron Works
Patterson Foundry & Machine Co.
Philadelphia Gear Works
Troy Engine & Machine Co.
Turbo-Mixer Div. General American Transportation Corp.
WESTERN MACHINERY CO.

AIRCRAFT

Auto-Lite Battery Corp.
Beech Aircraft Corp.
Bell Helicopter Corp.
Cessna Aircraft Co.
Goodyear Tire & Rubber Co.
Hiller Helicopters
Johnson Aircraft Co.
Sikorsky Div. United Aircraft Co.
Spartan Air Services
U. S. Rubber Co. Mechanical Goods Div.

AIR COMPRESSORS, MOVABLE & PORTABLE

Acme Machinery Co.
American Brake Shoe Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Beach-Russ Co.
Binks Mfg. Co.
Cardox Corp. Hardsocg Div.
CHICAGO PNEUMATIC TOOL CO.
Curtis Manufacturing Co.
Davey Compressor Co.
Equitable Powder Mfg. Co.
Essick Manufacturing Co.
GARDNER DENVER CO.
Hales Co., W. M.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Jaeger Machine Co.
JOY MFG. CO.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
O.K. Machinery Div. John C. Motter Printing Press Co.
Olin-Mathieson Chemical Corp. Explosives Div.
SCHRAMM, INC.
Schroeder Brothers
Smith & Co., Gordon
WESTINGHOUSE AIR BRAKE CO.
Worthington Corp.

AIR COMPRESSORS, ROTARY

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Beach-Russ Co.
CHICAGO PNEUMATIC TOOL CO.
Davey Compressor Co.
Fuller Co.
GARDNER DENVER CO.
Jaeger Machine Co.
JOY MFG. CO.
Nash Engineering Co.
Pickard Industries, Inc. Central Mines Supply Co., Div.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Wagner Electric Corp.
WESTINGHOUSE AIR BRAKE CO.
Worthington Corp.

AIR COMPRESSORS, STATIONARY

Acme Machinery Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Brake Shoe Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Cardox Corp. Hardsocg Div.
Carrier Corp.
CHICAGO PNEUMATIC TOOL CO.
Cooper-Bessemer Corp.
Curtis Manufacturing Co.
Davey Compressor Co.
Essick Manufacturing Co.
Fuller Co.
GARDNER DENVER CO.
Hales Co., W. M.
Holman Bros.—Canada Ltd.
Imperial-Cantrell Mfg. Co.
INGERSOLL-RAND CO.
Jaeger Machine Co.
JOY MFG. CO.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Lima Electric Motor Co.
Machinery Center Inc.
Nash Engineering Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Pennsylvania Pump & Compressor Co.
SCHRAMM, INC.
Smith & Co., Gordon
Spencer Turbine Co.
WESTINGHOUSE AIR BRAKE CO.
WESTINGHOUSE AIR BRAKE CO. IND. PRODUCTS DIV.
Worthington Corp.

AIR COMPRESSOR AFTERCOOLERS

Atlas Copco Pacific, Inc.
CHICAGO PNEUMATIC TOOL CO.
Curtis Manufacturing Co.
GARDNER DENVER CO.
INGERSOLL-RAND CO.
Johnson Corp.
JOY MFG. CO.
Pennsylvania Pump & Compressor Co.
Ross Heat Exchanger Div. American Standard
SCHRAMM, INC.
WESTINGHOUSE AIR BRAKE CO.

AIR LINE OILERS

Acme Machinery Co.
Atlas Copco Pacific, Inc.
CHICAGO PNEUMATIC TOOL CO.
Davey Compressor Co.
GARDNER DENVER CO.
Hayes Steel Products, Ltd.
INGERSOLL-RAND CO.
JOY MFG. CO.
SCHRAMM, INC.
Thor Power Tool Co.
Wilkerson Corp.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.
WESTINGHOUSE AIR BRAKE CO.
Wright Power Saw & Tool Corp. Subsidiary of Thomas Industries

(AIRLINE WATERTRAPS—see Pipeline Traps, Air, Steam & Water)

AIR MOTORS

Acme Machinery Co.
CHICAGO PNEUMATIC TOOL CO.
Detroit Hoist & Machine Co.
EIMCO CORP.
GARDNER DENVER CO.
INGERSOLL-RAND CO.
JOY MFG. CO.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Thor Power Tool Co.

(AIR PREHEATERS—see Heaters)

AIR RECEIVERS—also see Tanks

Acme Machinery Co.
Atlas Copco Pacific, Inc.
Canadian Locomotive Co., Ltd.
CHICAGO PNEUMATIC TOOL CO.
Curtis Manufacturing Co.
Davey Compressor Co.
Graver Tank & Mfg. Co., Inc.
INGERSOLL-RAND CO.
JOY MFG. CO.
WESTINGHOUSE AIR BRAKE CO.
WESTINGHOUSE AIR BRAKE CO. IND. PRODUCTS DIV.
Wilkerson Corp.

(AIR VALVES—see Valves)

AMALGAMATING PROCESS EQUIPMENT (SPECIAL)—does not include standard auxiliary equipment

DIESEL ENERGY CORP.
DENVER EQUIPMENT CO.
BLAW-KNOX CO.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.

(AMMETERS & VOLTMETERS—see Meters, Electricity)

(ANEMOMETERS—see Meters, Fluid)

(ARCH PLATES—see Mine Supports)

ARRESTERS, LIGHTNING

Carbone Corp.
Delta-Star Electric Div. H. K. Porter Company, Inc.
General Electric Co. Apparatus Sales Div.
Graybar Elc. Co., Inc.
Line Material Industries, McGraw-Edison Co.
Ohio Brass Co.
Westinghouse Electric Corp.

B

BAG FILLING MACHINES

Bemis Bro. Bag Co.
Chattanooga Boiler & Tank Co.
Consolidated Packaging Machinery Corp.
Fulton Bag & Cotton Mills, Bag Div.
Kraft Bag Corp.
Richardson Scale Co.
St. Regis Paper Co.

BAGS, PAPER, FABRIC & PLASTIC—also see: Blasting Bags; Filter Bags

Albany Felt Co.
Bemis Bro. Bag Co.
Chase Bag Co.
Daniels Co. Contractors, Inc.
Daniels, Inc., C. R.
Equitable Paper Bag Co., Inc.
Fulton Bag & Cotton Mills, Bag Div.
Kraft Bag Corp.
Miller Equipment Co., Inc.
National Filter Media Corp.
Pendleton Woolen Mills
St. Regis Paper Co.
Snyder & Son, Inc., M. L.
Stanley Co., Inc., William W.
Visking Co. Plastics Div.

(BALL MILLS—see Mills, Ball)

(BALLS, GRINDING—see Mill Balls)

(BATTERIES, ELECTRIC—see Electric Batteries)

BEARINGS, BALL

Aetna Ball & Roller Bearing Co., Div. Parkersburg-Aetna Corp.
Ahlberg Bearing Co.
Dodge Mfg. Corp.
Fafnir Bearing Co.
Federal Bearings Co., Inc.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc.
Gwilliam Co.
Kaydon Engineering Corp.
LINK-BELT CO. DEPT. EMJ-57
Marlin-Rockwell Corp.
New Departure Div. General Motors Corp.
Nice Ball Bearing Co.
Norma-Hoffman Bearings Corp.
SKF Industries, Inc.
Schatz Mfg. Co.
Split Ballbearing Corp.
Stephens-Adamson Mfg. Co.
Torrington Co.
Torrington Co. Bantam Bearings Div.

BEARINGS, NEEDLE

Kaydon Engineering Corp.
McGill Mfg. Co., Inc.
Orange Roller Bearing Co., Inc.
Torrington Co.
Torrington Co. Bantam Bearings Div.

BEARINGS, PLAIN, NON-METALLIC

American Brake Shoe Co.
Carbone Corp.
Gatke Corp.
Helwig Co.
McMillan's Sons, W. H.
Ohio Carbon Co.
Synthane Corp.

BEARINGS, PLAIN, OIL-IMPREGNATED & SINTERED METAL

Bunting Brass & Bronze Co.
Carbone Corp.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc.
Helwig Co.
Johnson Bronze Co.
Keystone Carbon Co.
Olds Alloy Co.
Pure Carbon Co.

BEARINGS, ROLLER

Aetna Ball & Roller Bearing Co. Div. Parkersburg-Aetna Corp.
Bower Roller Bearing Div. Federal-Mogul-Bower Bearings, Inc.
Chain Belt Co.
Chain Belt Co. Shafer Bearing Div.
Dodge Mfg. Corp.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc.
General Motors Corp. Hyatt Barings Div.
Gibraltar Equipment & Mfg. Co.
Gwilliam Co.
HEWITT-ROBINS, INC.
Kaydon Engineering Corp.
LINK-BELT CO. DEPT. EMJ-57
Marlin-Rockwell Corp.
McGill Mfg. Co., Inc.
Norma-Hoffman Bearings Corp.
Orange Roller Bearing Co., Inc.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Timken Roller Bearing Co.
Torrington Co.
Torrington Co. Bantam Bearings Div.
Tyson Bearing Corp. Subsidiary of SKF Industries, Inc.

BEARINGS, SLEEVE

American Brake Shoe Co.
American Crucible Products Co.
Ampco Metal, Inc.
Bunting Brass & Bronze Co.
Carbone Corp.
Dodge Mfg. Corp.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc.
Flood City Brass & Elec. Co.
Gatke Corp.
Haynes Stellite Co. Div. Union Carbide Corp.
Imperial-Cantrell Mfg. Co.
Johnson Bronze Co.
LINK-BELT CO. DEPT. EMJ-57
Ohio Carbon Co.
Olds Alloy Co.
STEARNS ROGER MFG. CO.
West Virginia Armature Co.
Williams & Son, E. A.

BEARINGS, THRUST

Aetna Ball & Roller Bearing Co. Div. Parkersburg-Aetna Corp.
American Brake Shoe Co.

American Crucible Products Co.
Brass Foundry Co.
Bunting Brass & Bronze Co.
Carbone Corp.
Federal Bearings Co., Inc.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc.
Gatke Corp.
Gibraltar Equipment & Mfg. Co.
Gwilliam Co.
Johnson Bronze Co.
Kaydon Engineering Corp.
LINK-BELT CO. DEPT. EMJ-57
Marlin-Rockwell Corp.
New Departure Div. General Motors Corp.
Nice Ball Bearing Co.
Ohio Carbon Co.
Olds Alloy Co.
Orange Roller Bearing Co., Inc.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Saginaw Bearing Co.
Schatz Mfg. Co.
Timken Roller Bearing Co.
Torrington Co.
Torrington Co. Bantam Bearings Div.
Williams & Son, E. A.

BEARING METAL

Aluminum Co. of America
American Brake Shoe Co.
American Crucible Products Co.
AMERICAN SMELTING & REFINING CO. FEDERATED METALS DIV.
Ampco Metal, Inc.
Belmont Smelting & Refining Works, Inc.
CRUCIBLE STEEL CO. OF AMERICA
Haynes Stellite Co. Div. Union Carbide Corp.
Imperial-Cantrell Mfg. Co.
Johnson Bronze Co.
LINK-BELT CO. DEPT. EMJ-57
Mueller Brass Co.
National Lead Co.
Olds Alloy Co.

BEARING PILLOW BLOCKS, HANGERS & JOURNAL BOXES

Ahlberg Bearing Co.
Bartlett & Snow Co., C. O.
CARD IRON WORKS, C. S.
Chain Belt Co.
Chain Belt Co. Shafer Bearing Div.
Continental Gin Co. Industrial Div.
Fafnir Bearing Co.
Gatke Corp.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
Johnson Bronze Co.
Kanawha Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
McNally Pittsburg Mfg. Corp.
New Departure Div. General Motors Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
SKF Industries, Inc.
Stephens-Adamson Mfg. Co.
Webster Mfg., Inc.
Wood's Sons Co., T. B.

(BELTS, CONVEYOR—see Conveyor Belting)

BELTS, FLAT POWER TRANSMISSION

Acme Rubber Mfg. Co.
American Rubber Mfg. Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Chicago Belting Div. Chicago-Allis Mfg. Corp.
Cincinnati Rubber Mfg. Co. Div. Thor Power Tool Co.
Dick Co., R. & J.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Graton & Knight Co. Inc.
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Houghton & Co., E. F.
Johnson Belting Co.
Manheim Mfg. & Belting Co.
Missouri Belting Co.
New York Belting & Packing Co.
New York Rubber Corp.
Philadelphia Belting Co.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Rhoads & Son, J. E.
Scandinavia Belting Co.
Thermoid Co. Industrial Div.
Thor Power Tool Co.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Webb Belting & Supply Co.
Williams, I. B. & Sons

BELTS, "V"

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Pulley Co.
Boston Woven Hose & Rubber Co.
Brammer Corp.
Browning Mfg. Co.
Carlyle Rubber Co.
Dick Co., R. & J.
Dodge Mfg. Corp.
GATES RUBBER CO.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Graton & Knight Co. Inc.
LINK-BELT CO. DEPT. EMJ-57
Manheim Mfg. & Belting Co.
Missouri Belting Co.
New York Belting & Packing Co.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Rhoads & Son, J. E.
Thermoid Co. Industrial Div.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Webb Belting & Supply Co.
Wood's Sons Co., T. B.
Worthington Corp.

BELT DRESSING

Chicago Belting Div. Chicago-Allis Mfg. Corp.
Cling-Surface Co.
Dixon Crucible Co., Joseph
Goodrich Industrial Products Co., B. F.
Graton & Knight Co. Inc.
Johnson Belting Co.
Missouri Belting Co.
Philadelphia Belting Co.
Rhoads & Son, J. E.
Scandinavia Belting Co.
Webb Belting & Supply Co.
Williams, I. B. & Sons

BINS & HOPPERS, BULK SOLIDS STORAGE

Acme Road Machinery Co., Inc.
Armco Drainage & Metal Products, Inc.
Arrow Tank Co.
Arrowhead Steel Buildings, Inc.
BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bartlett & Snow Co., C. O.
Bethlehem Steel Co., Inc.
Bodinson Manufacturing Co., Inc.
Butler Bin Co.
Canadian Locomotive Co., Ltd.
Columbian Steel Tank Co.
Connellsville Mfg. & Mine Supply Co.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
Enterprise Wheel & Car Corp.
Erie Strayer Co.
Graver Tank & Mfg. Co., Inc.
Gruendler Crusher & Pulverizer Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Industrial Engrg. & Construction Co.
IOWA MFG. CO.
Irwin Foundry & Mine Car Co.
Johnson Co., C. S.
Kanawha Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Kenyon Walker Machinery Co.
Kirk & Blum Mfg. Co.
Lakeside Bridge & Steel Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Mahon Co., R. C.
Marietta Concrete Corp.
Marsh Engineering Co., E. F.
MAYO TUNNEL & MINE EQUIPMENT CO.
Meckum Engineering, Inc.
Neff & Fry Co.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Pioneer Engineering Div. Poor & Co. Inc.
Prins & Associates, K.
Richardson Scale Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Santa Fe Tank Div. Fluor Products Co.
Specialty Engineering Co.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
Stephens-Adamson Mfg. Co.
Telluride Iron Works Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.

BIN & CHUTE GATES AND MECHANISMS—also see Feeders

Acme Road Machinery Co., Inc.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Butler Bin Co.
Canadian Locomotive Co., Ltd.
Chain Belt Co.
Columbus Conveyor Co.
DENVER EQUIPMENT CO.
Erie Strayer Co.
Gruendler Crusher & Pulverizer Co.
Helmich Foundry-Machine Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Industrial Engrg. & Construction Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
MAYO TUNNEL & MINE EQUIPMENT CO.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
NATIONAL IRON CO.
Ogden Iron Works
Pioneer Engineering Div. Poor & Co. Inc.
Prins & Associates, K.
Richardson Scale Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Smith Engineering Works
Specialty Engineering Co.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
Stephens-Adamson Mfg. Co.
Telluride Iron Works Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.

BIN & TANK-LEVEL INDICATORS

BIN-DICATOR CO.
BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
Butler Bin Co.
Convair, Inc.
Erie Strayer Co.
Falcon Alarm Co., Inc.
Femco, Inc.
Fuller Co.
General American Transportation Corp.
General Equipment & Mfg. Co.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
Nuclear Research Corp.
Santa Fe Tank Div. Fluor Products Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Texas Instruments, Inc. Industrial Instrumentation Div.

BLAST CLEANING EQUIPMENT

Norton Co.
Pangborn Corp.
Pettinos, Inc., George F.
Sly Mfg. Co., W. W.
U. S. Rubber Co. Mechanical Goods Div.
Wheelabrator Corp.

BLASTING COMPOUNDS (I.E. EXPLOSIVES)

AMERICAN CYANAMID CO. EXPLOSIVES DEPT.
Apache Powder Co.
ATLAS POWDER CO.
Canadian Industries Ltd.
Commercial Solvent Corp.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept.
DuPont de Nemours & Co., E. I. Equitable Powder Mfg. Co.
HERCULES POWDER CO.
Illinois Powder Mfg. Co.
King Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Spencer Chemical Co.
Trojan Powder Co.

BLASTING DETONATORS (I.E. CAPS)

AMERICAN CYANAMID CO. EXPLOSIVES DEPT.
ATLAS POWDER CO.
Canadian Industries Ltd.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept.
Equitable Powder Mfg. Co.
HERCULES POWDER CO.
Illinois Powder Mfg. Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Trojan Powder Co.

BLASTING FUSES, SAFETY, DETONATING, ET AL

AMERICAN CYANAMID CO. EXPLOSIVES DEPT.
ATLAS POWDER CO.
Canadian Industries Ltd.
Coast Mfg. & Supply Co.
DuPont de Nemours & Co., Inc., E. I. Explosives Dept.
DuPont de Nemours & Co., Inc., E. I.
ENSIGN-BICKFORD CO.
Equitable Powder Mfg. Co.
HERCULES POWDER CO.
Illinois Powder Mfg. Co.
National Fuse & Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Trojan Powder Co.

BLASTING BAGS, POWDER & TAMPING

AMERICAN CYANAMID CO. EXPLOSIVES DEPT.
Apache Powder Co.
ATLAS POWDER CO.
Canadian Industries Ltd.
Chase Bag Co.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept.
DuPont de Nemours & Co., E. I.
Fulton Bag & Cotton Mills, Bag Div.
HAMMOND CO., J. V.
Illinois Powder Mfg. Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Pickard Industries, Inc. Central Mines Supply Co., Div.
Trojan Powder Co.
Visking Co. Plastics Div.

BLASTING EQUIPMENT & ACCESSORIES

AMERICAN CYANAMID CO. EXPLOSIVES DEPT.
ATLAS POWDER CO.
Canadian Industries Ltd.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept.
Equitable Powder Mfg. Co.
Femco, Inc.
Gray Instrument Co.
HAMMOND CO., J. V.
HERCULES POWDER CO.
Illinois Powder Mfg. Co.
Johnson Loading Supplies, G. R.
National Fuse & Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Sprengnether Instrument Co., Inc. W.F.
Texas Instruments, Inc. Industrial Instrumentation Div.
Trojan Powder Co.
Victor Equipment Co. Alloy Rod & Metal Div.

BLASTING WIRE

AMERICAN CYANAMID CO. EXPLOSIVES DEPT.
ATLAS POWDER CO.
Canadian Industries Ltd.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc., E. I. Explosives Dept.
HERCULES POWDER CO.
Illinois Powder Mfg. Co.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Trojan Powder Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

BLOCKS, PULLEYS & SHEAVES—also see Sheaves, Mine Hoist

Alloy Steel & Metals Co.
American Hoist & Derrick Co.
American Pulley Co.
Bonded Scale & Machine Co.
CARD IRON WORKS, C. S.
Continental Gin Co. Industrial Div.
Dick Co., R. & J.
Dodge Mfg. Corp.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Frog, Switch & Mfg. Co.
Griphoist, Inc.
HEWITT-ROBINS, INC.
Holmes & Bros. Inc. Robert
JOY MFG. CO.
Keeney Co., Paul E.
Lake Shore, Inc. Lake Shore Engineering Div.
Lebus Mfg. Co. Subsidiary of American Hoist & Derrick Co.

Lovejoy Flexible Coupling Co.
Madesco Tackle Block Co.
McKiernan-Terry Corp.
McMillan's Sons, W. H.
McNally Pittsburg Mfg. Corp.
Paulsen-Webber Cordage Corp.
Princeton Gripholst, Inc.
SAUERMAN BROS., INC.
Skookum Co., Inc.
Telluride Iron Works Co.
Tool Steel Gear & Pinion Co.
U. S. Rubber Co. Mechanical Goods Div.
Washington Machinery Co.
Western Block Co.
Wood's Sons Co., T. B.

(BLOWERS—see: Fans; Concrete Sprayers; Refractory Placers)

BLUE, PHOTO & WHITE PRINT MACHINES

Bruning Co., Inc. Charles
Ozalid Div. General Aniline & Film Corp.
Paragon-Revolute Corp.
Pease Co., C. F.
Peck & Harvey Mfg. Corp.
Peerless Photo Products, Inc.
Post Co., Frederick
Remington Rand Div. Sperry Rand Corp.
Suverkrop Instruments

BOILERS & HEATERS, LIQUID— does not include: Heaters, Space; Retorts

Alco Products, Inc.
Ames Iron Works, Inc.
BABCOCK & WILCOX CO.
Combustion Engineering Inc.
Condenser Service & Engineering Co.
Foster Wheeler Corp.
Industrial Brownhoist Corp.
Keeler Co., E.
Leffel & Co., James
Ogden Iron Works
Process Engineering, Inc.
Prox Co., Inc. Frank
Quick Charge, Inc.
Ross Heat Exchanger Div. American Standard
Southwestern Engineering Co.
Springfield Boiler Co.

(BOLTS—see: Fasteners; Rock Bolts)

(BOOMS, LOADING—see: Cranes; Conveyors)

BRAKES, DYNAMIC—also see Brakes, Magnetic

Westinghouse Electric Corp.

BRAKES, FRICTION DISK & BLOCK

American Brake Shoe Co.
American Chain & Cable Co., Inc. Automotive & Aircraft Div.
Asbestos Mfg. Co.
Fawick Airflex Co., Inc.
Gatke Corp.
Goodyear Tire & Rubber Co.
Johns-Manville
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Wagner Electric Corp.
Wellman Co., S. K.

BRAKES, MAGNETIC

Clark Controller Co.
Cutler-Hammer, Inc.
DINGS MAGNETIC SEPARATOR CO.
Eaton Mfg. Co.
Electric Controller & Mfg. Co. Div. Square D. Co.
General Electric Co. Apparatus Sales Div.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Trombetta Solenoid Corp.
Westinghouse Electric Corp.

BRATTICE CLOTH

AMERICAN BRATTICE CLOTH CORP.
Flocker & Co., John
Fulton Bag & Cotton Mills, Bag Div.
Goodrich Industrial Products Co., B. F.
Johnston-Morehouse-Dickey Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
White Lamb Finaly, Inc.

(BREAKERS, CIRCUIT—see Electric Switchgear)

(BRUSHES, ELECTRICAL—see Electrical Brushes)

BUCKETS, BUCKETLINE DREDGE

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
AMERICAN BRAKE SHOE CO.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Sorel Steel Foundries, Ltd.
Washington Iron Works
Yaun Mfg. Co., Inc.
Yuba Manufacturing Co.

BUCKETS, CLAMSHELL & GRAB

AUSTIN-WESTERN WORKS CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Blaw-Knox Co.
Electric Steel Foundry Co.
Erie Strayer Co.
Frog, Switch & Mfg. Co.
Hales Co., W. M.
HARNISCHFEGER CORP.
Hayward Co.
Industrial Brownhoist Corp.
Johnson Co., C. S.
McKiernan-Terry Corp.
Orton Crane & Shovel Co.
Owen Bucket Co.
Pettibone Mulliken Corp.
Salem-Brosius, Inc.
Schield Bantam Co.
Wellman Engineering Co. McDowell Enterprise
Yaun Mfg. Co., Inc.
Yuba Manufacturing Co.

BUCKETS, CONVEYOR & ELEVATOR— does not include Buckets, Tramway & Trolley

Acme Road Machinery Co., Inc.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Butler Bin Co.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Continental Gin Co. Industrial Div.
Erie Strayer Co.
Farrell-Cheek Steel Co.
Gibraltar Equipment & Mfg. Co.
Goodrich Industrial Products Co., B. F.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kirk & Blum Mfg. Co.
Kremser & Sons, Inc. Frank A.
Laubenstein Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
McNally Pittsburg Mfg. Corp.
Ogden Iron Works
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co. Inc.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Savage Co., W. J.
Specialty Engineering Co.
Standard Metal Mfg. Co.
Stephens-Adamson Mfg. Co.
Union Chain & Mfg. Co.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Washington Machinery Co.
Webster Mfg., Inc.

BUCKETS, DIPPER SHOVEL

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
AMERICAN BRAKE SHOE CO.
Bucyrus-Erie Co.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Hendrix Mfg. Co.
Landis Steel Co.
Marion Power Shovel Co.
Orton Crane & Shovel Co.
Pettibone Mulliken Corp.
Schield Bantam Co.
Sorel Steel Foundries, Ltd.

BUCKETS, DRAGLINE CRANE

Bucyrus-Erie Co.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Hales Co., W. M.
HARNISCHFEGER CORP.
Marion Power Shovel Co.
Orton Crane & Shovel Co.
Page Engineering Co.
Schield Bantam Co.
Sorel Steel Foundries, Ltd.
Wellman Engineering Co. McDowell Enterprise
Yaun Mfg. Co., Inc.

BUCKETS, DRAGLINE SCRAPER-SLUSHER

Alloy Steel & Metals Co.
EIMCO CORP.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Landis Steel Co.
Orton Crane & Shovel Co.
Pettibone Mulliken Corp.
SAUERMAN BROS., INC.
VULCAN IRON WORKS CO., (DENVER)
Washington Machinery Co.
Yaun Mfg. Co., Inc.

BUCKETS, HOISTING & SINKING— does not include Skips & Cages

DENVER EQUIPMENT CO.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
MAYO TUNNEL & MINE EQUIPMENT CO.
Pollock Co., William B.
VULCAN IRON WORKS CO., (DENVER)
Yaun Mfg. Co., Inc.

BUCKETS, TRAMWAY & TROLLEY

Richards-Wilcox Mfg. Co.

BUCKET TEETH & WEAR-REPLACEMENT PARTS

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
AMERICAN BRAKE SHOE CO.
Bucyrus-Erie Co.
Electric Steel Foundry Co.
Erie Strayer Co.
Farrell-Cheek Steel Co.
Frog, Switch & Mfg. Co.
H. & L. Tooth Co.
Hayward Co.
Industrial Brownhoist Corp.
Industrial Overlay Metals, Inc.
Ladish Co.
Manganese Steel Forge Co.
Marion Power Shovel Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Owen Bucket Co.
SAUERMAN BROS., INC.
Sorel Steel Foundries, Ltd.
Wellman Engineering Co. McDowell Enterprise

BUILDINGS PREFAB

Armco Drainage & Metal Products, Inc.
Arrowhead Steel Buildings, Inc.
Black,Sivalls & Bryson, Inc.
Butler Manufacturing Co.
Dresser-Ideco Co.
Inland Steel Products Co.
Republic Steel Corp.
Republic Steel Corp. Truscon Steel Div.
Steel-Bilt Construction Co.
Steelcraft Mfg. Co.

(BULLDOZERS—see Tractor Attachments)

C

(CABLE—see: Electrical Cable; Wire Rope)

(CABLEWAYS—see Aerial Tramways)

(CAGES, MINE HOIST—see Skips & Cages)

(CALCULATORS—see: Drafting Instruments; Office Machines)

CAP LAMPS, CARBIDE

Geophysical Instrument & Supply Co.
Justrite Mfg. Co.

CAP LAMPS, ELECTRIC

Justrite Mfg. Co.
MINE SAFETY APPLIANCES CO.
National Carbon Co. Union Carbide Corp.
Nife, Inc.

CAP LAMP CARBIDE

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
Geophysical Instrument & Supply Co.
Linde Co. Union Carbide Corp.

CARBIDES, TUNGSTEN & OTHER HARD METALS (SINTERED, CEMENTED, ETC.)

ADAMAS CARBIDE CO.
Air Reduction Sales Co., Div. Air Reduction Co., Inc.
Allegheny Ludlum Steel Corp.
Carbone Corp.
Firth Sterling, Inc.
Hoyland Steel Co., Inc.
Industrial Overlay Metals, Inc.
KENNAMETAL INC. MINING TOOL DIV.
Metal Carbides Corp.
Metallurgical Products Dept. General Electric Co.
Newcomer Products, Inc.
Sight Feed Generator Co.
VASCOLOY-RAMET CORP.

CARS, COMMERCIAL RAILROAD

Ateco Div. Greenville Steel Car Co.
Dominion Steel & Coal Corp., Ltd.
Easton Car & Construction Co.
Frank, M. K.

CARS, MINE—also see specific types below

American Car & Foundry Div. ACF Industries, Inc.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Coeur d'Alene Hardware & Foundry Co.
Connellsville Mfg. & Mine Supply Co.
DENVER EQUIPMENT CO.
Differential Steel Car Co.
Dominion Steel & Coal Corp., Ltd.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Frank, M. K.
General American Transportation Corp.
Getman Brothers
Gibraltar Equipment & Mfg. Co.
Gregg Co. Ltd.
Helmich Foundry-Machine Co.
Hirsch Bros. Machy. Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Lake Shore, Inc. Lake Shore Engineering Div.
MAYO TUNNEL & MINE EQUIPMENT CO.
Machinery Center Inc.
Magor Car Corp.
Moran Engineering Co.
Sanford-Day Iron Works, Inc.
Telluride Iron Works Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Watt Car & Wheel Co.

CARS, MINE, AUTOMATIC DUMP

American Car & Foundry Div. ACF Industries, Inc.
Bethlehem Pacific Coast Steel Corp.
CARD IRON WORKS, C. S.
Differential Steel Car Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Frank, M. K.
Hirsch Bros. Machy. Co.
Irwin Foundry & Mine Car Co.
Lake Shore, Inc. Lake Shore Engineering Div.
Moran Engineering Co.
NATIONAL IRON CO.
Sanford-Day Iron Works, Inc.
Tennessee Coal & Iron Div. U. S. Steel Corp.

CARS, MINE, FIRE—also see Fire Fighting Equipment

Irwin Foundry & Mine Car Co.
MINE SAFETY APPLIANCES CO.

CARS, MINE, HAND DUMP

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
DENVER EQUIPMENT CO.
Differential Steel Car Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Frank, M. K.
Hirsch Bros. Machy. Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Lake Shore, Inc. Lake Shore Engineering Div.
MAYO TUNNEL & MINE EQUIPMENT CO.
Moran Engineering Co.
Ogden Iron Works
Sanford-Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, MINE, MAN & SPECIAL MATERIAL

Bethlehem Pacific Coast Steel Corp.

Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Differential Steel Car Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Frank, M. K.
Getman Brothers
Gibraltar Equipment & Mfg. Co.
Hirsch Bros. Machy. Co.
Hockensmith Corp.
Holmes & Bros., Inc. Robert
Irwin Foundry & Mine Car Co.
Kersey Mfg. Co., Inc.
Lake Shore, Inc. Lake Shore Engineering Div.
Lee-Norse Co.
Moran Engineering Co.
Ogden Iron Works
Sanford-Day Iron Works, Inc.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Watt Car & Wheel Co.

(CAR ACCESSORIES, MINE & COMMERCIAL R.R.—see below; also see: Track. . .; Rail. . .)

CAR CAGERS & SPOTTERS—does not include Car Movers

CARD IRON WORKS, C. S.
Connellsville Mfg. & Mine Supply Co.
Flood City Brass & Elec. Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH, c/o B. J. Nykerk Corp.
Nolan Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
STAMLER CORP., W. R.

CAR COUPLERS & DRAFT GEAR

CARD IRON WORKS, C. S.
Differential Steel Car Co.
Duquesne Mine Supply Co.
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Frank, M. K.
MAYO TUNNEL & MINE EQUIPMENT CO.
Moran Engineering Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Ohio Brass Co.
Utility Mine Equipment Co.

CAR DERAILERS & RERAILERS & CHOCKS—does not include switch-type derailers; see Rail Switches

ALDON CO.
Duquesne Mine Supply Co.
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Frank, M. K.
Miners' Hardware Supply Co.
Nolan Co.
Pettibone Mulliken Corp.
Sanford-Day Iron Works, Inc.

CAR (& TRUCK) DUMPING DEVICES

CARD IRON WORKS, C. S.
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Easton Car & Construction Co.
Frank, M. K.
Galion Allsteel Body Co.
Hercules Steel Products Corp.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
Industrial Brownhoist Corp.
Kanawha Mfg. Co.
Lake Shore, Inc. Lake Shore Engineering Div.
LINK-BELT CO. DEPT. EMJ-57
McKiernan-Terry Corp.
McNally Pittsburg Mfg. Corp.
Moran Engineering Co.
Nolan Co.
Ottumwa Box Car Loader Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
Wellman Engineering Co. McDowell Enterprise

CAR MOVERS, HAND

Advance Car Mover Co., Inc.
ALDON CO.
Atlas Car & Mfg. Co.
Christian Engineers, J. D.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
McNally Pittsburg Mfg. Corp.

CAR MOVERS, SPECIAL TRACTOR TYPE

Easton Car & Construction Co.
Frank, M. K.
Hough Co., Frank G.
LE TOURNEAU-WESTINGHOUSE CO.
WESTINGHOUSE AIR BRAKE CO.
Whiting Corp.

CAR MOVERS, WINCH TYPE

Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Christian Engineers, J. D.
Clyde Iron Works, Inc.
Electro Lift, Inc.
Foster Co., L. B.
Frank, M. K.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
Jeffrey Mfg. Co.
JOY MFG. CO.
Lidgerwood Industries, Inc.
LINK-BELT CO. DEPT. EMJ-57
McKiernan-Terry Corp.
McNally Pittsburg Mfg. Corp.
O.K. Machinery Div. John C. Motter Printing Press Co.
Sanford-Day Iron Works, Inc.
Silent Hoist & Crane Corp.
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
VULCAN IRON WORKS CO., (DENVER)
Washington Machinery Co.
Webster Mfg., Inc.

CAR RETARDERS

Connellsville Mfg. & Mine Supply Co.
Frank, M. K.
Heyl & Patterson, Inc.
Holmes & Bros., Inc. Robert
LINK-BELT CO. DEPT. EMJ-57
McNally Pittsburg Mfg. Corp.
Miners' Hardware Supply Co.
Nolan Co.
Sanford-Day Iron Works, Inc.
Webster Mfg., Inc.
WESTINGHOUSE AIR BRAKE CO.

CAR SHAKERS

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Frank, M. K.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
LINK-BELT CO. DEPT. EMJ-57
Martin Engineering Co.
Webster Mfg., Inc.

CAR TRANSFERS, PASSERS, ETC.

AMERICAN MINE DOOR CO.
Atlas Car & Mfg. Co.
CARD IRON WORKS, C. S.
Easton Car & Construction Co.
Frank, M. K.
MAYO TUNNEL & MINE EQUIPMENT CO.
Telluride Iron Works Co.

CAR TURNTABLES

Atlas Car & Mfg. Co.
Bethlehem Pacific Coast Steel Corp.
CARD IRON WORKS, C. S.
Easton Car & Construction Co.
Foster Co., L. B.
Frank, M. K.
Irwin Foundry & Mine Car Co.
MAYO TUNNEL & MINE EQUIPMENT CO.
Whiting Corp.

CAR (& LOCOMOTIVE) WHEELS & AXLES

Alco Products, Inc.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Car & Foundry Div. ACF Industries, Inc.
BALDWIN - LIMA - HAMILTON CORP. STANDARD STEEL WORKS DIV.
Canadian Locomotive Co., Ltd.
CARD IRON WORKS, C. S.
Differential Steel Car Co.
Dominion Steel & Coal Corp., Ltd.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Farrell-Cheek Steel Co.
Frank, M. K.
Hockensmith Corp.
Ironton Engine Co.
Irwin Foundry & Mine Car Co.
Kersey Mfg. Co., Inc.
Moran Engineering Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Rogers Iron Works Co.
Sterling Steel Casting Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

CASTING WHEELS, SMELTER

Treadwell Co., M. H.

CAR WHEEL & GEAR PULLERS

Armstrong, Bray & Co.
Crane Puller Co.
Frank, M. K.
Owatonna Tool Co.

CASTINGS, IRON (GRAY, MALLEABLE ETC.)

American Brake Shoe Co.
American Car & Foundry Div. ACF Industries, Inc.
Auto-Lite Battery Corp.
Badger Malleable & Mfg. Co.
Belle City Malleable Iron Co. Racine Steel Castings Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Cadillac Malleable Iron Co.
Calumet Div. Calumet & Hecla, Inc.
CARD IRON WORKS, C. S.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Cooper-Bessemer Corp.
Davis Foundry & Machine Works
Enterprise Wheel & Car Corp.
Farrel-Birmingham Co., Inc.
Gibraltar Equipment & Mfg. Co.
Goyne Pump Co.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Lake Shore, Inc. Lake Shore Engineering Div.
LINK-BELT CO. DEPT. EMJ-57
McLanahan & Stone Corp.
Meeker Foundry Co.
NATIONAL IRON CO.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NORDBERG MFG. CO.
Ogden Iron Works
Prox Co., Inc. Frank
Sheppard Co., Inc., R. H.
Square D Co.
Rogers Iron Works Co.
St. Louis Malleable Casting Co.
Sanford-Day Iron Works, Inc.
Shriver & Co., T.
STEARNS ROGER MFG. CO.
Swett Iron Works, A. L.
Telluride Iron Works Co.
Union Chain & Mfg. Co.
U. S. Pipe & Foundry Co.
Washington Iron Works
Webster Mfg., Inc.
Wood's Sons Co., T. B.

CASTINGS, FERROUS ALLOYS

Allegheny Ludlum Steel Corp.
AMERICAN BRAKE SHOE CO.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Atlas Steel Casting Co.
Auto-Lite Battery Corp.
BABCOCK & WILCOX CO.
Belle City Malleable Iron Co. Racine Steel Castings Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Calumet Div. Calumet & Hecla, Inc.
CRUCIBLE STEEL CO. OF AMERICA
DART TRUCK CO.
Duriron Co., Inc.
Electric Steel Foundry Co.
Empire Steel Castings, Inc.
Enterprise Wheel & Car Corp.
Farrell-Cheek Steel Co.
Gibraltar Equipment & Mfg. Co.
Goyne Pump Co.
Industrial Overlay Metals, Inc.
Kanawha Mfg. Co.
Kensington Steel Co.
Lebanon Steel Foundry
Los Angeles Steel Casting Co.
McNally Pittsburg Mfg. Corp.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NATIONAL SUPPLY CO.
Sawyer Belt Hook & Wedge Co., Inc.
STEARNS ROGER MFG. CO.
Taylor-Wharton Co. Div. Harsco Corp.
Thomas Foundries, Inc.

CASTINGS, NONFERROUS

Aluminum Co. of America
AMERICAN BRAKE SHOE CO.
Ampco Metal, Inc.
Belmont Smelting & Refining Works
Beryllium Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Brass Foundry Co.
Bridgeport Brass Co.
Cadman Mfg. Co., A. W.
CRUCIBLE STEEL CO. OF AMERICA
Enterprise Wheel & Car Corp.
Flood City Brass & Elec. Co.
Gibraltar Equipment & Mfg. Co.
Goyne Pump Co.
Haynes Stellite Co. Div. Union Carbide Corp.
HOFFMAN BROS. DRILLING CO.
International Nickel Co.
Leavitt Machine Co.
Lumen Bearing Co.
Mueller Brass Co.
National Lead Co.
Ogden Iron Works
Olds Alloy Co.
Permold Co.
Sawyer Belt Hook & Wedge Co., Inc.
Shriver & Co., T.
Star Brass Works
Stoody Co.
Titan Metal Mfg. Co.
West Virginia Armature Co.
Williams & Son, E. A.

CASTINGS, STEEL

Acme Machinery Co.
Alloy Steel & Metals Co.
AMERICAN BRAKE SHOE CO.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Steel Foundries
Atlas Steel Casting Co.
BABCOCK & WILCOX CO.
BALDWIN - LIMA - HAMILTON CORP. STANDARD STEEL WORKS DIV.
Belle City Malleable Iron Co. Racine Steel Castings Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Birdsboro Steel Foundry & Machine Co.
CARD IRON WORKS, C. S.
CRUCIBLE STEEL CO. OF AMERICA
Duriron Co., Inc.
Electric Steel Foundry Co.
Empire Steel Castings, Inc.
FALK CORP.
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Frog, Switch & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Jessop Steel Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Lebanon Steel Foundry
Los Angeles Steel Casting Co.
NATIONAL IRON CO.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Sorel Steel Foundries, Ltd.
Sterling Steel Casting Co.
Stroh Process Steel Co.
Strong Steel Foundry Co.
Taylor-Wharton Co. Div. Harsco Corp.
Thomas Foundries, Inc.
Washington Iron Works

CHAIN, CAST & WELDED

AMERICAN BRAKE SHOE CO.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Chain Div. American Chain & Cable Co., Inc.
Bridgeport Chain & Mfg. Co.
Chain Belt Co.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Co.
LINK-BELT CO. DEPT. EMJ-57
McNally Pittsburg Mfg. Corp.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Olds Alloy Co.
Paulsen-Webber Cordage Corp.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Taylor Chain Co. Inc., S. G.
Taylor-Wharton Co. Div. Harsco Corp.
Union Chain & Mfg. Co.

CHAIN, POWER TRANSMISSION

Atlas Chain & Mfg. Co.
Bartlett & Snow Co., C. O.
Browning Mfg. Co.
Chain Belt Co.
Christian Engineers, J. D.
Continental Gin Co. Industrial Div.
Cullman Wheel Co.
Diamond Chain Co., Inc.
Dick Co., R. & J.
Dodge Mfg. Corp.
Jeffrey Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
McNally Pittsburg Mfg. Corp.
Morse Chain Co., A Borg-Warner Industry
Olds Alloy Co.
Union Chain & Mfg. Co.
Whitney Chain Co.

CHAIN FITTINGS & ACCESSORIES

American Chain Div. American Chain & Cable Co., Inc.
American Hoist & Derrick Co.
Chain Belt Co.
Diamond Chain Co., Inc.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Hayes Steel Products, Ltd.
Interstate Drop Forge Co.
Jeffrey Mfg. Co.
Lebus Mfg. Co. Subsidiary of American Hoist & Derrick Co.
LINK-BELT CO. DEPT. EMJ-57
Madesco Tackle Block Co.
Newhall Chain Forge & Iron Co.
Paulsen-Webber Cordage Corp.
Republic Steel Corp.
Taylor Chain Co. Inc., S. G.
Taylor-Wharton Co. Div. Harsco Corp.
Union Chain & Mfg. Co.

CHAIN SLINGS

AMERICAN BRAKE SHOE CO.
American Chain Div. American Chain & Cable Co., Inc.
Electric Steel Foundry Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
McMillan's Sons, W. H.
Newhall Chain Forge & Iron Co.
Paulsen-Webber Cordage Corp.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Taylor Chain Co. Inc., S. G.

(CHAIN SPROCKETS—see Gears)

CHANGE ROOM EQUIPMENT

Moore Co.

CHEMICALS—also see: Flotation Reagents; Water Treatment Chemicals

Aluminum Co. of America
AMERICAN CYANAMID CO. MINING CHEMICALS DEPT.
American Sand-Banum Co., Inc.
Armour & Co.
ATLAS POWDER CO.
Baker Chemical Co., J. T.
Belmont Smelting & Refining Works, Inc.
Canadian Industries Ltd.
Commercial Solvent Corp.
Dow Chemical Co.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept.
Emery Industries, Inc.
Fisher Scientific Co.
Food Machinery & Chemical Corp. Westvaco Mineral Products Div. Westvaco Chlor-Alkali Div.
Fuel Process Co.
GENERAL CHEMICAL DIV. ALLIED CHEMICAL & DYE CORP. BAKER & ADAMSON PRODUCTS
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
General Mills, Inc.
HERCULES POWDER CO.
Mallinckrodt Chemical Works
Marathon Corp.
Monsanto Chemical Co.
Oronite Chemical Co.
Pacific Lumber Co.
Pennsalt Chemicals Corp.
Philadelphia Quartz Co.
Reilly Tar & Chemical Corp.
Rohm & Haas Co.
Solvay Process Div. Allied Chemical & Dye Corp.
Stein, Hall & Co., Inc.
Sylvania Electric Products, Inc.
Texas Gulf Sulphur Co.
Union Carbide Chemicals Co. Union Carbide Corp.
Van Waters & Rogers, Inc.
Wyandotte Chemicals Corp.

(CLASSIFIERS—see below; also see: Filters; Separators; Screens; Thickeners)

CLASSIFIERS, AIR, CENTRIFUGAL & SIMILAR—does not include Classifiers, Cyclone

Centrifugal & Mech. Industries, Inc.
Combustion Engineering, Inc. Raymond Div.
HARDINGE CO., INC.
HUMPHREYS INVESTMENT CO. ENGINEERING DIV.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Majac Inc.
SHARPLES CORP.
STURTEVANT MILL CO.
Telluride Iron Works Co.
Universal Road Machinery Co.

CLASSIFIERS, BELT & DRAG

Acme Road Machinery Co., Inc.
Bodinson Manufacturing Co., Inc.
DENVER EQUIPMENT CO.
HEWITT-ROBINS, INC.
Jeffrey Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Meckum Engineering, Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Pioneer Engineering Div. Poor & Co. Inc.
Rogers Iron Works Co.
Telluride Iron Works Co.
Washington Machinery Co.

CLASSIFIERS, BOWL

Acme Road Machinery Co., Inc.
Dorr Oliver, Inc.
Link-Belt Co. Dept. EMJ-57
Machinery Center Inc.

CLASSIFIERS, CYCLONE, DRY

BUELL ENGINEERING CO.
Convair, Inc.
Drilling Accessory & Mfg. Co., Inc.
Ducon, Inc.
Hazemag m. b. H.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Kirk & Blum Mfg. Co.
STURTEVANT MILL CO.

CLASSIFIERS, CYCLONE, WET

Atlantic Tank Corp.
Centrifugal & Mech. Industries, Inc.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
EQUIPMENT ENGINEERS INC.
Georgia Iron Works Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc
Smith Engineering Works
Telluride Iron Works Co.

CLASSIFIERS, HYDRAULIC FLOW (SETTLING)

Deister Concentrator Co.
DENVER EQUIPMENT CO.
EAGLE IRON WORKS
HARDINGE CO., INC.
Heyl & Patterson, Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Smith Engineering Works
WESTERN MACHINERY CO.

CLASSIFIERS, HYDRAULIC CENTRIFUGAL (CENTRIFUGES, ET AL)—does not include Classifiers, Cyclone

BIRD MACHINE CO.
Centrifugal & Mech. Industries, Inc.
COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO.
Condenser Service & Engineering Co.
Deister Concentrator Co.
Deister Machine Co.
DENVER EQUIPMENT CO.
Fahrenwald Co., A. W.
Heyl & Patterson, Inc.
LINK-BELT CO. DEPT. EMJ-57
Meckum Engineering, Inc.

CLASSIFIERS, RAKE

Bodinson Manufacturing Co., Inc.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Machinery Center Inc.
MORSE BROS. MACHINERY CO.
Washington Machinery Co.

CLASSIFIERS, SPIRAL-SCREW (MECHANICAL)

Acme Road Machinery Co., Inc.
Canadian Locomotive Co., Ltd.
COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO.
DENVER EQUIPMENT CO.
EAGLE IRON WORKS
Hirsch Bros. Machy. Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Machinery Center Inc.
McLanahan & Stone Corp.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Smith Engineering Works
Straub Mfg. Co.
WESTERN MACHINERY CO.

(CLOCKS—see Meters, Time)

CLOTH & FABRICS—also see; Bags; Brattice Cloth; Filter Cloth, Insulation Cloth; Tarpaulins, Ventilation Tubing; Wire Cloth

Albany Felt Co.
AMERICAN BRATTICE CLOTH CORP.
House & Sons, Inc. Chas. W.
Daniels, Inc., C. R.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
Filtration Engineers, Inc. Sub. of Amer. Machine & Metals, Inc.
Gatke Corp.
Irvington Div. Minnesota Mining & Mfg. Co.
Johns-Manville
Korb-Pettit Wire Fabrics & Iron Works
Ludlow-Saylor Wire Cloth Co.
Multi-Metal Wire Cloth Co., Inc.
National Filter Media Corp.
Newark Wire Cloth Co.
Pendleton Woolen Mills
Safety Clothing & Equipment Co.
Snyder & Son, Inc., M. L.
Stanley Co., Inc., William W.
Turner Halsey Co.
Union Asbestos & Rubber Co.
U. S. Rubber Co.
Wellington Sears Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

(CLUTCHES, FLUID—see Drives, Fluid)

CLUTCHES, FRICTION

American Flexible Coupling Div. Zurn Industries, Inc.
Asbestos Mfg. Co.
Centric Clutch Co.
Dodge Mfg. Corp.
Eaton Mfg. Co.
Fawick Airflex Co., Inc.
Gatke Corp.
Jeffrey Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Marland One-Way Clutch Co.
Morse Chain Co. A Borg-Warner Industry
TWIN DISC CLUTCH CO.
Wellman Co., S. K.

(CLUTCHES, MAGNETIC—see Drives, Magnetic)

(COATINGS, ABRASION-RESISTANT, METALLIC—see Hardfacing)

COATINGS, ABRASION-RESISTANT, NON-METALLIC—does not include Linings

Aluminum Co. of America
Carboline Co.
DENVER EQUIPMENT CO.
DuPont de Nemours & Co., E. I.
Eagle-Picher Co.
GALIGHER CO.
Gates Engrg. Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Haynes Stellite Co. Div. Union Carbide Corp.
Master Bronze Powder Co., Inc.
Norton Co.
Permagile Corp. of America
Quigley Co., Inc.
Reilly Tar & Chemical Corp.
Rust-Oleum Corp.
Sauereisen Cement Co.
Sherwin-Williams Co.
Slip-On, Inc.
U. S. Rubber Co.
Wilbur & Williams Co.
Zophar Mills, Inc.

(COATINGS, CHEMICAL & CORROSION-RESISTANT, METALLIC—see Metallizing)

COATINGS, CHEMICAL & CORROSION-RESISTANT, NON-METALLIC—does not include: Linings; Paints

American Hard Rubber Co.
American Sand-Banum Co., Inc.
Atlantic Refining Co.
Borne Scrymser Co.
Cabot, Inc., Samuel
Carboline Co.
Carbolineum Wood Preserving Co.
Carey Mfg. Co., Philip
DENVER EQUIPMENT CO.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
Eagle-Picher Co.
Foster Co., L. B.
GALIGHER CO.
Gates Engrg. Co.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Gulf Oil Corp.
Irvington Div. Minnesota Mining & Mfg. Co.
Johns-Manville
Koppers Co. Inc.
Luzerne Rubber Co.
Minnesota Mining & Mfg. Co.
Monsanto Chemical Co.
National Carbon Co. Union Carbide Corp.
Norton Co.
Pennsalt Chemicals Corp.
Permagile Corp. of America
Philadelphia Quartz Co.
Sauereisen Cement Co.
Sika Chemical Corp.
Slip-On, Inc.
Solvay Process Div. Allied Chemical & Dye Corp.
Sun Oil Co.
U. S. Rubber Co.
Valvoline Oil Co. Div. Ashland Oil & Refining Co.
Zophar Mills, Inc.

COMMUNICATIONS, AUDIBLE SIGNAL (BELL, BUZZER, HORN, ETC.)—also see below

Falcon Alarm Co., Inc.
FEDERAL SIGN & SIGNAL CORP.
Femco, Inc.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Patrick & Wilkins Co.
Talk-A-Phone Co.
Wheelco Instr. Div. Barber-Coleman Co.

COMMUNICATIONS, RADIO

Automatic Electric Co.
Elgin National Watch Co.
Federal Telephone & Radio Div. International Telephone and Telegraph Corp.
Femco, Inc.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Industrial Physics & Electronics Co.
Motorola Communications & Electronics, Inc.
Radio Corp. of America Communications Products Dept.
Spartan Air Services

COMMUNICATIONS, TELEPHONE

Ansonia Wire & Cable Co.
Automatic Electric Co.
Elgin National Watch Co.
Federal Telephone & Radio Div. International Telephone and Telegraph Corp.
Femco, Inc.
Graybar Elec. Co., Inc.
Hose-McCann Telephone Co.
Industrial Physics & Electronics Co
MINE SAFETY APPLIANCES CO.
WESTINGHOUSE AIR BRAKE CO.
Wheeler Insulated Wire Co., Div. Sperry Rand Corp.

COMMUNICATIONS, TELEVISION

Diamond Power Specialty Corp.
Elgin National Watch Co.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Tatler & Cooper, Inc.

COMMUNICATIONS, VISUAL SIGNAL (LIGHTS, SEMAPHORE, ETC.)—also see above and Rail Signals; does not include Signs)

AMERICAN MINE DOOR CO.
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
FEDERAL SIGN & SIGNAL CORP.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
NATIONAL FILTER MEDIA CORP.
NACHOD & U. S. SIGNAL CO.
WESTINGHOUSE AIR BRAKE CO.

(COMPRESSORS—see Air Compressors)

(CONCENTRATORS—see Separators)

CONCRETE ADDITIVES (DISPERSANTS, ANTIFREEZE, ETC.)

Canadian Industries Ltd.
Dewey & Almy Chemical Co., Div. W. R. Grace & Co.
Dow Chemical Co.
HERCULES POWDER CO.
Heyl & Patterson, Inc.
Johns-Manville
Master Builders Co.
Monsanto Chemical Co.
Sika Chemical Corp.
Wyandotte Chemicals Corp.

CONCRETE GROUT PUMPS

Drilling Accessory & Mfg. Co., Inc.
Koehring Co.
MAYO TUNNEL & MINE EQUIPMENT CO.
Pickard Industries, Inc. Central Mine Supply Co., Div.

CONCRETE PUMPS & PLACERS—does not include Sprayers

Air Placement Equip. Co.
Chain Belt Co.
CHICAGO PNEUMATIC TOOL CO.

CONCRETE SPRAYERS & BLOWERS

Air Placement Equip. Co.
Cement Gun Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.

(CONDENSERS—see Coolers)

CONTINUOUS MINERS & PLANERS—also see: Cutting Machines; for bits see Cutting Machine Bits

Compton, Inc.
Jeffrey Mfg. Co.
JOY MFG. CO.
Lee-Norse Co.
Westfalia Lunen
WESTINGHOUSE AIR BRAKE CO.
Wilcox Mfg. Co.

CONTRACTORS, AERIAL EXPLORATION, MAPPING, ETC.

Abrams Aerial Survey Corp.
AERO SERVICE CORP.
AERO SERVICE CORP. (MID-CONTINENT)
AERO SERVICE CORP. (WESTERN)
AFRICAN SURVEYS (PTY.), LTD.
American Air Surveys, Inc.
Ammann Photogrametric Engineers, Inc, Jack
CANADIAN AERO SERVICE LTD.
Cummings Jr., & Associates, Robt. A.
Fairchild Aerial Surveys, Inc.
Laylander, Philip A.
Nuclear Exploration Co.
Resources Development Corp.
Spartan Air Services

CONTRACTORS, CONSTRUCTION, MINE PLANT

CARPO MANUFACTURING, INC.
Catalytic Construction Co.
Daniels Co. Contractors, Inc.
Elgin Corp.
Hack Engineering Co.
Industrial Engrg. & Construction Co.
Kaiser Engineers
McKee & Co., Arthur G.
Minerals Engineering Co.
NATIONAL IRON CO.
STEARNS ROGER MFG. CO.
Stone & Webster Engineering Co.
Telluride Iron Works Co.
Universal Dredge Mfg. Co.
Walvoord, Inc., O. W.
WESTERN MACHINERY CO.
Winston Bros. Co.

CONTRACTORS, DESIGN, MINE

Chapman & Wood
Hack Engineering Co.
Industrial Engrg. & Construction Co.
Kaiser Engineers
Menlo Research Laboratory
STEARNS ROGER MFG. CO.
Stone & Webster Engineering Co.
Telluride Iron Works Co.
Universal Dredge Mfg. Co.
WESTERN MACHINERY CO.
Winston Bros. Co.

CONTRACTORS, DESIGN, MINERAL REFINERY

CARPCO MANUFACTURING, INC.
Catalytic Construction Co.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
Hack Engineering Co.
Kaiser Engineers
McKee & Co., Arthur G.
Menlo Research Laboratory
Minerals Engineering Co.
STEARNS ROGER MFG. CO.
Stone & Webster Engineering Co.
Universal Dredge Mfg. Co.
Vitro Corp. of America
Walvoord, Inc., O. W.

CONTRACTORS, DRILLING (EXPLORATION)

Acker Drill Co.
Black Diamond Spade Co.
BOOTH CO.
BOYLES BROS. DRILLING CO., LTD.
BOYLES BROS. DRILLING CO. (UTAH)
Brosites Products Corp.
CARPCO MANUFACTURING, INC.
Chapman & Wood
HOFFMAN BROS. DRILLING CO.
JOY MFG. CO.
Manu-Mine Research & Devel. Co.
McDonald Drilling Co., Inc.
McKinney Drilling Co.
Minerals Engineering Co.
MOBILE DRILLING & ENGINEERING INC., DIV MOBILE DRILLING INC.
MOBILE DRILLING, INC.
Mott Core Drilling Co.
Nuclear Exploration Co.
Pennsylvania Drilling Co.
SPRAGUE & HENWOOD, INC.
WESTERN MACHINERY CO.
Winston Bros. Co.

CONTRACTORS, GEOLOGICAL SERVICE

Abrams Aerial Survey Corp.
American Air Surveys, Inc.
Chapman & Wood
Engineers Syndicate, Ltd.
Hycon Aerial Surveys, Inc.
Laylander, Philip A.
McPhar Geophysics, Ltd.
MOBILE DRILLING, INC.
MOBILE DRILLING & ENGINEERING INC., DIV MOBILE DRILLING INC.
Nuclear Exploration Co.
Pennsylvania Drilling Co.
Resources Development Corp.
Spartan Air Services

CONTRACTORS, GEOPHYSICAL SERVICE

American Air Surveys, Inc.
Engineers Syndicate, Ltd.
Fairchild Aerial Surveys, Inc.
Hycon Aerial Surveys, Inc.
Lundberg Explorations, Ltd.
McPhar Geophysics, Ltd.
MOBILE DRILLING, INC.
MOBILE DRILLING & ENGINEERING INC., DIV MOBILE DRILLING INC.
Nuclear Exploration Co.
Resources Development Corp.
Seismograph Service Corp.
Spartan Air Services

CONTRACTORS, MAPPING (TOPO, SURVEY)

AERO SERVICE CORP.
AERO SERVICE CORP. (MID-CONTINENT)
AERO SERVICE CORP. (WESTERN)
AFRICAN SURVEYS (PTY.), LTD.
American Air Surveys, Inc.
Ammann Photogrametric Engineers, Inc. Jack
CANADIAN AERO SERVICE LTD.
Chapman & Wood
Cummings Jr., & Associates, Robt. A.
Fairchild Aerial Surveys, Inc.
Gurley, W. & L. E.
Hycon Aerial Surveys, Inc.
Spartan Air Services

CONTRACTORS, MINING, DREDGING

Fitz Simons & Connell Dredge & Dock Co.
Hack Engineering Co.
Universal Dredge Mfg. Co.
Winston Bros. Co.

CONTRACTORS, MINING, OPEN PIT

Fitz Simons & Connell Dredge & Dock Co.
Foley Bros. Construction Co.
Hack Engineering Co.
Hales Co., W. M.
Minerals Engineering Co.
Universal Dredge Mfg. Co.
Utah Construction Co.
Winston Bros. Co.

CONTRACTORS, MINING, SHAFT, ADIT & TUNNEL

BOYLES BROS. DRILLING CO. (UTAH)
DRAVO CORP.
Elgin Corp.
Fitz Simons & Connell Dredge & Dock Co.
Frazier Davis Construction Co.
Johnson Co., R. G.
McKinney Drilling Co.
Pennsylvania Drilling Co.
Stone & Webster Engineering Co.
Utah Construction Co.
Winston Bros. Co.

CONTRACTORS, MINING, STRIPPING

Fitz Simons & Connell Dredge & Dock Co.
Hack Engineering Co.
Hales Co., W. M.
Minerals Engineering Co.
Universal Dredge Mfg. Co.
Utah Construction Co.
Winston Bros. Co.

CONTRACTORS, MINING, UNDERGROUND

BOYLES BROS. DRILLING CO. (UTAH)
Fitz Simons & Connell Dredge & Dock Co.
Frazier Davis Construction Co.
Hack Engineering Co.
Hales Co., W. M.
Minerals Engineering Co.
Universal Dredge Mfg. Co.
Winston Bros. Co.

CONTRACTORS, ORE LOADING PIERS & WHARVES

DeLong Engineering Corp.

CONTROLS, ELECTRICAL & ELECTRONIC (AUTOMATIC, REMOTE, INDICATING, RECORDING, ETC)—also see: Meters; Communications

Aerofall Mills, Inc.
Allen-Bradley Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Allis Co., Louis
American Instrument Co., Inc.
Arrow Hart & Hegeman Electric Co.
Assembly Products, Inc.
Auto-Lite Battery Corp.
Automatic Electric Co.
Automatic Switch Co.
Bailey Meter Co.
Blue M Electric Co.
Bristol Co.
BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
Chatillon & Sons, John
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Clark Controller Co.
Consolidated Electrodynamics Corp.
Control Corp.
Convair, Inc.
Cutler-Hammer, Inc.
Dietz Co., Henry G.
Electric Controller & Mfg. Co. Div. Square D Co.
Electro Products Laboratories
Elgin National Watch Co.
Ensign Electric & Mfg. Co.
Erie Strayer Co.
Falcon Alarm Co., Inc.
Federal Pacific Electric Co.
Federal Pacific Electric Co. Pacinc Switchgear Div.
Femco, Inc.
Fisher & Porter Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Hart Mfg. Co.
Illinois Testing Laboratories, Inc.
Industrial Physics & Electronics Co.
Infilco, Inc.
Isotope Products, Inc. Instrument Div.
Johnson Corp.
Kurz & Root Co.
Minneapolis-Honeywell Regulator Co.
Minneapolis Honeywell Regulator Co. Brown Instrument Div
Minneapolis-Honeywell Regulator Co. Industrial Div.
NACHOD & U. S. SIGNAL CO.
NATIONAL FILTER MEDIA CORP.
Norden-Ketay Corp.
Nuclear Research Corp.
Ohio Electric Mfg. Co.
Paragon Electric Co.
Philips Electronics, Inc. Instruments Div.
Pittsburgh Electrical & Machine Works
Reliance Electric & Engineering Co.
Republic Flow Meters Co.
Revere Corp. of America
Richards-Wilcox Mfg. Co.
Richardson Scale Co.
Sangamo Electric Co.
Streeter-Amet Co.
Taller & Cooper, Inc.
Texas Instruments, Inc. Industrial Instrumentation Div.
WESTINGHOUSE AIR BRAKE CO.
Westinghouse Electric Corp.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.
Wheico Instr. Div. Barber-Colman Co.

(CONTROLS, ELECTRIC MOTOR—see Electric Motor Controls)

CONTROLS, HYDRAULIC & PNEUMATIC (AUTO. REMOTE, ETC.)—also see Meters

American Chain & Cable Co., Inc. Automotive & Aircraft Div.
American Instrument Co., Inc.
Automatic Switch Co.
Bailey Meter Co.
Bristol Co.
BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
Cash Co., A. W.
Clark Controller Co.
Fisher & Porter Co.
General Equipment & Mfg. Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Hunt & Son, Inc., C. B.
Industrial Physics & Electronics Co.
Infilco, Inc.
Minneapolis-Honeywell Regulator Co.
Minneapolis Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Oilgear Co.
Owatonna Tool Co.
Pittsburgh Electrical & Machine Works
Republic Flow Meters Co.
Taller & Cooper, Inc.
Vickers Inc.
WESTINGHOUSE AIR BRAKE CO.
WESTINGHOUSE AIR BRAKE CO. IND. PRODUCTS DIV.

CONVERTERS, METAL

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
TRAYLOR ENGINEERING & MFG. CO.
Telluride Iron Works Co.

CONVEYOR BELTING

Acme Road Machinery Co., Inc.
Acme Rubber Mfg. Co.
American Rubber Mfg. Co.
BARBER-GREENE CO.
Boston Woven Hose & Rubber Co.
Cambridge Wire Cloth Co.
Carlyle Rubber Co.
Chicago Belting Div. Chicago-Allis Mfg. Corp.
Daniels, Inc., C. R.
Dick Co., R. & J.
Gibraltar Equipment & Mfg. Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
IOWA MFG. CO.
Korb-Pettit Wire Fabrics & Iron Works
LINK-BELT CO. DEPT. EMJ-57
Missouri Belting Co.
New York Belting & Packing Co.
New York Rubber Corp.
Northern Conveyor Co.
Philadelphia Belting Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Richardson Scale Co.
Sandvik Steel Inc. Steel Belt Conveyor Dept.
Scandinavia Belting Co.
Specialty Engineering Co.
Thermoid Co. Industrial Div.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div
Webb Belting & Supply Co.
West Virginia Belt & Cable Repairs, Inc.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

CONVEYOR BELTING FASTENERS

Acme Road Machinery Co., Inc.
American Rubber Mfg. Co.
Armstrong, Bray & Co.
Clipper Belt Lacer Co.
Crescent Belt Fastener Co., Inc.
Dick Co., R. & J.
Flexible Steel Lacing Co.
General Splice Corp.
Goodall Rubber Co.
HEWITT-ROBINS, INC.
Northern Conveyor Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Raybestos-Manhattan, Inc., Manhattan Rubber Div.
Sawyer Belt Hook & Wedge Co., Inc.
Talcott, Inc.
Webb Belting & Supply Co.

West Virginia Belt & Cable Repairs, Inc.

CONVEYOR BELTING VULCANIZERS

Flexible Steel Lacing Co.
Food Machinery & Chemical Corp. Packing Equipment Div.
Heintz Mfg. Co.
West Virginia Belt & Cable Repairs, Inc.

(CONVEYORS, APRON—see Conveyors, Pan)

CONVEYORS, BELT—for belting alone, see Conveyor Belting

Acme Road Machinery Co., Inc.
American Conveyor Co.
American Rubber Mfg. Co.
Atlas Conveyor Co.
BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
BARBER-GREENE CO.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Cambridge Wire Cloth Co.
CARPCO MANUFACTURING, INC.
Chain Belt Co.
Cincinnati Rubber Mfg. Co. Div. Thor Power Tool Co.
Columbus Conveyor Co.
Compton, Inc.
Continental Gin Co. Industrial Div.
Conveyor Systems, Inc.
Diamond Iron Works Div. Goodman Mfg. Co.
GALIGHER CO.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Hirsch Bros. Machy. Co.
Industrial Engrg. & Construction Co.
IOWA MFG. CO.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
JOY MFG. CO.
Kremser & Sons, Inc. Frank A.
Lake Shore, Inc. Lake Shore Engineering Div.
Lamson Corp.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Machinery Center Inc.
Marsh Engineering Co., E. F.
MAYO TUNNEL & MINE EQUIPMENT CO.
McNally Pittsburg Mfg. Corp.
Mekum Engineering, Inc.
MORSE BROS. MACHINERY CO.
Northern Conveyor Co.
Ogden Iron Works
Oliver Corp. A. B. Farquhar Div.
Philadelphia Belting Co.
Pioneer Engineering Div. Poor & Co. Inc.
Richardson Scale Co.
Rogers Iron Works Co.
Sandvik Steel Inc. Steel Belt Conveyor Dept.
Savage Co., W. J.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
STURTEVANT MILL CO.
U. S. Rubber Co. Mechanical Goods Div.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.
Yuba Manufacturing Co.

CONVEYORS, BELT, HOLDBACKS

Marland One-Way Clutch Co.

CONVEYORS, BELT, IDLERS & PULLEYS

Acme Road Machinery Co., Inc.
American Pulley Co.
Atlas Conveyor Co.
BARBER-GREENE CO.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Continental Gin Co. Industrial Div.
Davis Foundry & Machine Works
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
Dick Co., R. & J.
Food Machinery & Chemical Corp. Packing Equipment Div.
GALIGHER CO.
Goodyear Tire & Rubber Co.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
IOWA MFG. CO.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
JOY MFG. CO.
Kanawha Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Kremser & Sons, Inc. Frank A.
Lamson Corp.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Machinery Center Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Ogden Iron Works
Pettibone Mulliken Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div. Poor & Co. Inc.
Ridge Equipment Co.
Rogers Iron Works Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
U. S. Rubber Co. Mechanical Goods Div.
Washington Machinery Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.
Yuba Manufacturing Co.

CONVEYORS, BELT, TAKE-UPS

Acme Road Machinery Co., Inc.
Atlas Conveyor Co.
BARBER-GREENE CO.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co. Industrial Div.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
JOY MFG. CO.
Kanawha Mfg. Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Ogden Iron Works
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div. Poor & Co. Inc.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.
Yuba Manufacturing Co.

CONVEYORS, BELT, TRIPPERS

Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co. Industrial Div.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Jeffrey Mfg. Co.
JOY MFG. CO.
Kanawha Mfg. Co.
Lamson Corp.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Ogden Iron Works
Oliver Corp. A. B. Farquhar Div.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.

CONVEYOR (& ELEVATORS), BUCKET—does not include Conveyors, Trolley

Acme Road Machinery Co., Inc.
American Conveyor Co.
Atlas Conveyor Co.
BARBER-GREENE CO.
Bonded Scale & Machine Co.
Butler Bin Co.
CARPCO MANUFACTURING, INC.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Continental Gin Co. Industrial Div.
Conveyor Systems, Inc.
DENVER EQUIPMENT CO.
Erie Strayer Co.
GALIGHER CO.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Northern Conveyor Co.
Ogden Iron Works
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div. Poor & Co. Inc.
Richardson Scale Co.
Ridge Equipment Co.
Rogers Iron Works Co.
Smith Engineering Works
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
STURTEVANT MILL CO.
Transport Trailers, Inc.
Union Chain & Mfg. Co.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Savage Co., W. J.
Washington Machinery Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.

CONVEYORS, CHAIN (PACKAGE)

Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Christian Engineers, J. D.
Compton, Inc.
Conveyor Systems, Inc.
Electric Steel Foundry Co.
Erie Strayer Co.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hapman Conveyors, Inc.
Hirsch Bros. Machy. Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Long Co.
Northern Conveyor Co.
Oliver Corp. A. B. Farquhar Div.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Richards-Wilcox Mfg. Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Union Chain & Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Whitney Chain Co.

CONVEYORS, CHAIN, DRAG & SCRAPER, (BULK)—does not include Dragline Scraper-Slusher

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Atlas Conveyor Co.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Columbus Conveyor Co.
Compton, Inc.
Continental Gin Co. Industrial Div.
Conveyor Systems, Inc.
Hack Engineering Co.
Hapman Conveyors, Inc.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
McNally Pittsburg Mfg. Corp.
Northern Conveyor Co.
Oliver Corp. A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Pettibone Mulliken Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
SAUERMAN BROS., INC.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Union Chain & Mfg. Co.
U. S. Rubber Co. Mechanical Goods Div.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.

CONVEYORS, MOVABLE & EXTENSIBLE—also see Conveyors, Section, Self-Propelled

American Conveyor Co.
American Pulley Co.
BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
BARBER-GREENE CO.
Bonded Scale & Machine Co.
Carrier Conveyor Corp.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Irwin Foundry & Mine Car Co.
Pettibone Mulliken Corp.
JOY MFG. CO.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
Oliver Corp.
Oliver Corp. A. B. Farquhar Div.
Ottumwa Box Car Loader Co.
Richards-Wilcox Mfg. Co.
Rogers Iron Works Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.
Wilcox Mfg. Co.

CONVEYORS, PAN & APRON

Acme Road Machinery Co., Inc.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Carrier Conveyor Corp.
Chain Belt Co.
Christian Engineers, J. D.
Columbus Conveyor Co.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co. Industrial Div.
Conveyor Systems, Inc.
Diamond Iron Works Div. Goodman Mfg. Co.
Food Machinery & Chemical Corp. Packing Equipment Div.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Heyl & Patterson, Inc.
Hirsch Bros. Machy. Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
JOY MFG. CO.
Kanawha Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
Prins & Associates, K.
Lamson Corp.
Machinery Center Inc.
McNally Pittsburg Mfg. Corp.
NATIONAL IRON CO.
Pioneer Engineering Div. Poor & Co. Inc.
Holmes & Bros., Inc. Robert
Ogden Iron Works
Pettibone Mulliken Corp.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Rogers Iron Works Co.
SIMPLICITY ENGINEERING CO.
Simplicity System Co.
Smith Engineering Works
Sorel Steel Foundries, Ltd.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Taylor-Wharton Co. Div. Harsco Corp.
Telluride Iron Works Co.
Union Chain & Mfg. Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.
Webb Co., Jervis B.
Webster Mfg., Inc.

CONVEYORS, PNEUMATIC

Allen-Sherman-Hoff Co.
Convair, Inc.
General American Transportation Corp.
Gruendler Crusher & Pulverizer Co.
Fuller Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
Lamson Corp.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
Robinson Air-Activated Conveyor Systems
Specialty Engineering Co.
Spencer Turbine Co.
Universal Dredge Mfg. Co.

CONVEYORS, ROLLER, GRAVITY & POWERED (PACKAGE)

American Conveyor Co.
American Pulley Co.
Bonded Scale & Machine Co.
Conveyor Systems, Inc.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hapman Conveyors, Inc.
Lamson Corp.
Lippmann Engineering Works, Inc.
Oliver Corp.
Oliver Corp. A. B. Farquhar Div.
Richards-Wilcox Mfg. Co.
Specialty Engineering Co.
Webb Belting & Supply Co.

CONVEYORS, SCREW OR SPIRAL

Atlas Conveyor Co.
Bartlett & Snow Co., C. O.
Butler Bin Co.
Cambridge Wire Cloth Co.
CARPCO MANUFACTURING INC.
Christian Engineers, J. D.
Columbus Conveyor Co.
Continental Gin Co. Industrial Div.
Erie Strayer Co.
Food Machinery & Chemical Corp. Packing Equipment Div.
Hack Engineering Co.
Hapman Conveyors, Inc.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. DEPT. EMJ-57
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Northern Conveyor Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Richardson Scale Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc
Specialty Engineering Co.
STURTEVANT MILL CO.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.
Webster Mfg., Inc.

CONVEYORS, SECTIONAL, PREFAB—does not include Conveyors, Movable

Acme Road Machinery Co., Inc.
Atlas Conveyor Co.
BARBER-GREENE CO.
Bonded Scale & Machine Co.
Connellsville Mfg. & Mine Supply Co.
Continental Gin Co. Industrial Div.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hapman Conveyors, Inc.
HEWITT-ROBINS, INC.
Irwin Foundry & Mine Car Co.
JOY MFG. CO.
Kremser & Sons, Inc. Frank A.
Lamson Corp.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Marsh Engineering Co., E. F.
Oliver Corp. A. B. Farquhar Div.
Rogers Iron Works Co.
Specialty Engineering Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.

CONVEYORS, SECTIONAL, SELF-PROPELLED

Continental Gin Co. Industrial Div.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Irwin Foundry & Mine Car Co.
Kremser & Sons, Inc. Frank A.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Northern Conveyor Co.
Universal Dredge Mfg. Co.
Webb Belting & Supply Co.

CONVEYORS, SHAKING & VIBRATING—also see Feeders

Ajax Flexible Coupling Co.
Atlas Conveyor Co.
Branford Co.
CARPCO MANUFACTURING, INC.
Carrier Conveyor Corp.
Chain Belt Co.
Conveyor Systems, Inc.
DIESEL ENERGY CORP.
DRAVO CORP.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. DEPT. EMJ-57
Overstrom & Sons, Inc.
Richardson Scale Co.
Ridge Equipment Co.
SIMPLICITY ENGINEERING CO.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.
Webb Belting & Supply Co.

CONVEYORS, TROLLEY—does not include Aerial Tramways & Cableways

Conveyor Systems, Inc.
Hapman Conveyors, Inc.
Lamson Corp.
LINK-BELT CO. DEPT. EMJ-57
Louden Machinery Co.
Richards-Wilcox Mfg. Co.
Specialty Engineering Co.
Webb Co., Jervis B.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

COOLERS (& CONDENSERS), LIQUID & GAS PROCESS—does not include Air Compressor Aftercoolers

Alco Products, Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Canadian Locomotive Co., Ltd.
Carrier Corp.
Condenser Service & Engineering Co.
Curtis Manufacturing Co.
Foster Wheeler Corp.
Lilie-Hoffmann Cooling Towers, Inc.
Marley Co.
Ogden Iron Works
Process Engineering, Inc.
Ross Heat Exchanger Div. American Standard
Yaun Mfg. Co., Inc.

COOLERS, SOLIDS

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Bartlett & Snow Co., C. O.
Carrier Conveyor Corp.
Christian Engineers, J. D.
General American Transportation Corp. Louisville Dryer Div.
General American Transportation Corp.
HARDINGE CO., INC.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. DEPT. EMJ-57
NORDBERG MFG. CO.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
Vulcan Iron Works
Western Precipitation Corp.
Yaun Mfg. Co., Inc.

(CORE BARRELS—see Drill (Rock) Core Barrels)

(COUPLERS, MINE CAR—see Car Couplers)

(COUPLINGS—see below; also see: Drill Steel; Pipe Fittings)

(COUPLINGS, MECHANICAL POWER TRANSMISSION—see below; also see: Clutches; Drives; Hubs)

COUPLINGS, M. P. T., FLEXIBLE

Ajax Flexible Coupling Co.
American Flexible Coupling Div. Zurn Industries, Inc.
Arrowhead Products Div. Federal-Mogul-Bower, Bearings Inc.
Browning Mg. Co.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Cullman Wheel Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
F. A. B. Mfg. Co.
FALK CORP.
Farrel-Birmingham Co., Inc.
Jeffrey Mfg. Co.
Koppers Co., Inc. Metal Prod. Div.
LINK-BELT CO. DEPT. EMJ-57
Marland One-Way Clutch Co.
Morse Chain Co. A Borg-Warner Industry
Philadelphia Gear Works
Poole Foundry & Machine Co.
Smith & Serrell, Inc.
Stratoflex, Inc.
Thomas Flexible Coupling Co.
Waldron Corp., John
Weatherhead Co. Fort Wayne Div.
Western Gear Corp.
Whitney Chain Co.
Wood's Sons Co., T. B.

COUPLINGS, M. P. T., FLUID—see Drives, Fluid)

COUPLINGS, M. P. T., RIDGID

Arrowhead Products Div. Federal-Mogul-Bower, Bearings Inc.
Browning Mfg. Co.
Continental Gin Co. Industrial Div.
Cullman Wheel Co.
Dodge Mfg. Corp.
Farrel-Birmingham Co., Inc.
LINK-BELT CO. DEPT. EMJ-57
Mueller Brass Co.
Poole Foundry & Machine Co.
Stratoflex, Inc.
Waldron Corp., John
Weatherhead Co. Fort Wayne Div.
Western Gear Corp.
Wood's Sons Co., T. B.

CRANES, DERRICK BOOM, CRAWLER, LOCOMOTIVE & WHEELED

American Hoist & Derrick Co.
AUSTIN-WESTERN WORKS CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clyde Iron Works, Inc.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
Hyster Co.
Industrial Brownhoist Corp.
Insley Manufacturing Corp.
Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Maxi Corp.
Northwest Engineering Co.
Ohio Locomotive Crane Co.
Orton Crane & Shovel Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Silent Hoist & Crane Corp.
Thew Shovel Co.
Unit Crane & Shovel Corp.
Wellman Engineering Co. McDowell Enterprise

CRANES, DERRICK, STATIONARY (OVER 10-TON)

American Hoist & Derrick Co.
Clyde Iron Works, Inc.
Conco Engineering Works
Lakeside Bridge & Steel Co.
Northwest Engineering Co.
Orton Crange & Shovel Co.
Shepard Niles Crane & Hoist Corp.
Unit Crane & Shovel Corp.
Wiley Mfg. Co.

CRANES, JIB (OVER 10-TON)

Clark Equipment Co. Construction Machinery Div.
LE TOURNEAU-WESTINGHOUSE CO.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Orton Crane & Shovel Co.
Shepard Niles Crane & Hoist Corp.
Specialty Engineering Co.
Wellman Engineering Co. McDowell Enterprise
Whiting Corp.

CRANES, JIB & DERRICK (UNDER 10-TON LIFT)

American Chain & Cable Co., Inc. Wright Hoist Div.
American Hoist & Derrick Co.
Anthony Co.
Chisholm-Moore Hoist Div. Columbus McKinnon Chain Corp.
Cleveland Crane & Engrg. Co.
Clyde Iron Works, Inc.
Hack Engineering Co.
Harrington Co.
LE TOURNEAU-WESTINGHOUSE CO.
Louden Machinery Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Orton Crane & Shovel Co.
Pitman Mfg. Co.
Reading Crane & Hoist Corp.
Richards-Wilcox Mfg. Co.
Round & Son, Inc., David
Shepard Niles Crane & Hoist Corp.
Silent Hoist & Crane Corp.
Universal Dredge Mfg. Co.
Wellman Engineering Co. McDowell Enterprise
WESTINGHOUSE AIR BRAKE CO.

CRANES, OVERHEAD-TRAVELING, GANTRY & BRIDGE, MONORAIL

American Chain & Cable Co., Inc. Wright Hoist Div.
American Hoist & Derrick Co.
Chisholm-Moore Hoist Div. Columbus McKinnon Chain Corp.
Cleveland Crane & Engrg. Co.
Clyde Iron Works, Inc.
Conco Engineering Works
Detroit Hoist & Machine Co.
DRAVO CORP.
Forker Corp.
Hack Engineering Co.
HARNISCHFEGER CORP.
Harrington Co.
Heyl & Patterson, Inc.
Industrial Brownhoist Corp.
Lakeside Bridge & Steel Co.
Louden Machinery Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
McKiernan-Terry Corp.
Pacific Cost Engineering Co.
Reading Crane & Hoist Corp.
Richards-Wilcox Mfg. Co.
Robbins & Myers, Inc.
Round & Sons, Inc., David
Shepard Niles Crane & Hoist Corp.
Specialty Engineering Co.
STEARNS ROGER MFG. CO.
Universal Dredge Mfg. Co.
Washington Iron Works
Webb Co., Jervis B.
Willman Engineering Co. McDowell Enterprise
Whiting Corp.
Wiley Mfg. Co.

CRANKSHAFTS, DIESEL ENGINE

MORCO, INC.

(CRUSHERS—see below; also see: Mills; Pulverizers)

CRUSHERS, CONE

Acme Road Machinery Co., Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Fahrenwald Co., A. W.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Lippmann Engineering Works, Inc.
Machinery Center Inc.
NORDBERG MFG. CO.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Smith Engineering Works

CRUSHERS, DISK

KENNEDY-VAN SAUN MFG. & ENG. CORP.
NORDBERG MFG. CO.
STURTEVANT MILL CO.

CRUSHERS, GYRATORY

Acme Road Machinery Co., Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
KENNEDY-VAN SAUN MFG. & Eng. CORP.
Machinery Center Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
NORDBERG MFG. CO.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Smith Engineering Works
Straub Mfg. Co
TRAYLOR ENGINEERING & MFG. CO.

CRUSHERS, HAMMER

Acme Road Machinery Co., Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Pulverizer Co.
Bartlett & Snow Co., C. O.
Buffalo Hammer Mill Corp.
Diamond Iron Works Div. Goodman Mfg. Co.
DIESEL ENERGY CORP.
Gruendler Crusher & Pulverizer Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Lippmann Engineering Works, Inc.
Metal Carbides Corp.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Rogers Iron Works Co.
Specialty Engineering Co.
STURTEVANT MILL CO.
Universal Engineering Corp.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, IMPACT

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Pulverizer Co.
Fahrenwald Co., A. W.
Gruendler Crusher & Pulverizer Co.
Hazmag m.b.H.
IOWA MFG. CO.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Lippmann Engineering Works, Inc.
Mead Mill Co.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
NORDBERG MFG. CO.

Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
STURTEVANT MILL CO.
Universal Engineering Corp.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, JAW

Acme Road Machinery Co., Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Alloy Steel & Metals Co.
Bacon-Green & Milroy
BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bico, Inc.
Birdsboro Steel Foundry & Machine Co.
DENVER EQUIPMENT CO.
Denver Fire Clay Co.
Diamond Iron Works Div. Goodman Mfg. Co.
DIESEL ENERGY CORP.
Fahrenwald Co., A. W.
Farrell-Birmingham Co., Inc.
Gruendler Crusher & Pulverizer Co.
IOWA MFG. CO.
Jeffrey Mfg. Co
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Lippmann Engineering Works, Inc.
McLanahan & Stone Corp.
Machinery Center Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
MORSE BROS. MACHINERY CO.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Rogers Iron Works Co.
Smith Engineering Works
Straub Mfg. Co.
Streb Process Steel Co.
STURTEVANT MILL CO.
TRAYLOR ENGINEERING & MFG. CO.
Universal Engineering Corp.
Universal Road Machinery Co.

CRUSHERS, MOBILE UNITS

Acme Road Machinery Co., Inc.
BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bonded Scale & Machine Co.
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Gundlach Machine Co., T. J. Div. of JMJ Industries, Inc.
Hazemag m.b.H.
IOWA MFG. CO.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
NORDBERG MFG. CO.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Rogers Iron Works Co.
Smith Engineering Works
Straub Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.

CRUSHERS, RING ROLL

Abbe' Engineering Co.
American Pulverizer Co.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Stephens-Adamson Mfg. Co.
STURTEVANT MILL CO.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, ROLL

Abbe' Engineering Co.
Acme Road Machinery Co., Inc.
Allen-Sherman-Hoff Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bartlett & Snow Co., C.O.
Bonded Scale & Machine Co
COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO.
Diamond Iron Works Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Gundlach Machine Co., T. J. Div. of JMJ Industries, INC.
HEWITT-ROBINS, INC.
IOWA MFG. CO.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Machinery Center Inc.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
Metal Carbides Corp.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Ridge Equipment Co.
Rogers Iron Works Co.
Smith Engineering Works
STURTEVANT MILL CO.
TRAYLOR ENGINEERING & MFG. CO.
Universal Engineering Corp.
Williams Patent Crusher & Pulverizer Co.

CRUSHER PARTS

Acme Road Machinery Co., Inc.
Alco Products, Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Alloy Steel & Metals Co.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Forge Co.
BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
BALDWIN-LIMA-HAMILTON CORP. STANDARD STEEL WORKS DIV.
Bico, Inc.
Bonded Scale & Machine Co.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Gatke Corp.
Hirsch Bros. Machy. Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Kensington Steel Co.
Lippmann Engineering Works, Inc.
Metal Carbides Corp.
Pennsylvania Crusher Div. Bath Iron Works Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Div. Poor & Co., Inc.
Sorel Steel Foundries, Ltd.
Specialty Engineering Co.
Thomas Foundries Inc.
Tool Steel Gear & Pinion Co.
TRAYLOR ENGINEERING & MFG. CO.
Universal Engineering Corp.
Williams Patent Crusher & Pulverizer Co.

CUTTING MACHINES (ROCK)—does not include Continuous Miners & Planers

American Instrument Co., Inc.
Clipper Mfg. Co.
Hales Co., W. M.
JOY MFG. CO.
Salem Tool Co.
WESTINGHOUSE AIR BRAKE CO.

CUTTING MACHINE BITS (ROCK)

Allegheny Ludlum Steel Corp.
Cincinnati Mine Mach'y Co.
CRUCIBLE STEEL CO. OF AMERICA
Firth Sterling, Inc.
Hales Co., W. M.
HOFFMAN BROS. DRILLING CO.
KENNAMETAL INC. MINING TOOL DIV.
Marathon Coal Bit Co. Inc.
Metallurgical Products Dept. General Electric Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Salem Tool Co.
VASCOLOY-RAMET CORP.
WESTINGHOUSE AIR BRAKE CO.

CUTTING MACHINE PARTS (ROCK)

Cincinnati Mine Mach'y Co.
Flood City Brass & Elec. Co.
JOY MFG. CO.
Mining Machine Parts, Inc.
Penn Machine Co.
Salem Tool Co.
Simonds Worden White Co.
WESTINGHOUSE AIR BRAKE CO.

(CYANIDE—see Chemicals)

CYANIDING PROCESS EQUIPMENT (SPECIAL)—does not include standard auxiliary equipment

DENVER EQUIPMENT CO.
Machinery Center, Inc.
National Tank & Pipe Co.

(CYCLONES—see Classifiers, Cyclone)

CYLINDERS, AIR & HYDRAULIC

Anthony Co.
Benton Harbor Engineering Works, Inc.
CARD IRON WORKS, C. S.
Commercial Shearing & Stamping Co.
Erie Strayer Co.
Galland Henning Mfg. Co. Nopak Div.
Kidde & Co., Inc., Walter
Ledeen, Inc.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Moran Engineering Co.
Oilgear Co.
Owatonna Tool Co.
Star Jack Co.
Telluride Iron Works Co.
Vickers Inc.
Wellman Engineering Co. McDowell Enterprise
WESTINGHOUSE AIR BRAKE CO.
WESTINGHOUSE AIR BRAKE CO. IND. PRODUCTS DIV.

D

(DENSITY METERS—see Meters, Liquid & Slurry, Density)

DIAMONDS, INDUSTRIAL

American Coldset Corp.
Diamond Drill Carbon Co.
Diamond Products, Inc.
DIAMOND TOOL RESEARCH CO., INC.
HOFFMAN BROS. DRILLING CO.
Koebel Diamond Tool Co.
Metal Carbides Corp.
SMIT & CO., ANTON
SMIT & SONS, INC., J. K.
SPRAGUE & HENWOOD, INC.
Varel Mfg. Co.
Willey's Carbide Tool Co.

DIAMOND CONCENTRATING EQUIPMENT (SPECIAL)—does not include standard auxiliary equipment

DENVER EQUIPMENT CO.
HOFFMAN BROS. DRILLING CO.

(DIPPER SHOVELS—see Excavators)

DRAFTING EQUIPMENT & SUPPLIES —also see Blu, Photo & White Print Machines

Berger & Sons, C. L., Inc.
Black Diamond Spad Co.
Bruning Co., Inc. Charles
Dixon Crucible Co., Joseph
Go-Optic Co., Inc.
Gerber Scientific Instrument Co.
Keuffel & Esser Co.
Pease Co., C. F.
Post Co., Frederick
Suverkrop Instruments
Warren-Knight Co.

(DRAGLINES—see Excavators)

(DRAGLINE SCRAPER-SLUSHERS—see: Buckets; Hoists; Excavators, Dragline Tower)

(DREDGES—see below; also see: Buckets, Hoists, Excavators)

DREDGES, BUCKETLINE

C & D Div. Yuba Manufacturing Co.
DRAVO CORP.
Ellicott Machine Corp.
Washington Iron Works
Yuba Manufacturing Co.

DREDGES, DIPPER SHOVEL

DRAVO CORP.
Ellicott Machine Corp.
Sorel Steel Foundries, Ltd.

DREDGES, DRAGLINE & GRAB CRANE

American Hoist & Derrick Co.
Bodinson Manufacturing Co., Inc.
DRAVO CORP.
Ellicott Machine Corp.
Hyster Co.

DREDGES SUCTION

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Hoist & Derrick Co.
C & D Div. Yuba Manufacturing Co.
EAGLE IRON WORKS
Ellicott Machine Corp.
Erie Pump & Engine Works
Essick Manufacturing Co.
Hack Engineering Co.
Mackum Engineering, Inc.
Morris Machine Works
Pacific Coast Engineering Co.
Universal Dredge Mfg. Co.
Yuba Manufacturing Co.

DREDGE HULLS

American Hoist & Derrick Co.
Bodinson Manufacturing Co., Inc.
C & D Div. Yuba Manufacturing Co.
DRAVO CORP.
Ellicott Machine Corp.
Meckum Engineering, Inc.
Pacific Coast Engineering Co.
Wiley Mfg. Co.
Yuba Manufacturing Co.

DREDGE SLEEVES

Ellicott Machine Corp.
Goodrich Industrial Products Co., B. F.
HEWITT-ROBINS, INC.
New York Belting & Packing Co.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.

(DRILLS, HAND, PORTABLE ELECTRIC —see Tools, Hand, Power)

DRILLS (ROCK & EARTH), AUGER (SURFACE RIG)

Acker Drill Co.
Cardox Corp. Hardsocg Div.
CHICAGO PNEUMATIC TOOL CO.
GARDNER DENVER CO.
HOFFMAN BROS. DRILLING CO.
Holman Bros.—Canada Ltd.
Leetonia Tool Co.
Mayhew Machine & Supply Co.
Metallurgical Products Dept. General Electric Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Salem Tool Co.
Stardrill-Keystone Co.
Thor Power Tool Co.
Worthington Corp.

DRILLS (ROCK), CHURN

Bucyrus-Erie Co.
GARDNER DENVER CO.
HOFFMAN BROS. DRILLING CO.
HOSSFELD MFG. CO.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
Spang & Co.
Stardrill-Keystone Co.

DRILLS (ROCK), DIAMOND

Acker Drill Co.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CHICAGO PNEUMATIC TOOL CO.
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
DIAMOND TOOL RESEARCH CO., INC.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Havlick, J. L.
HOFFMAN BROS. DRILLING CO.
JOY MFG. CO.
Koebel Diamond Tool Co.
LONGYEAR CO., E. J.
Machinery Center, Inc.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Mott Cor Drilling Co.
Packsack Diamond Drills, Ltd.
Pennsylvania Drilling Co.
SPRAGUE & HENWOOD, INC.
Stardrill-Keystone Co.

DRILLS (ROCK), FLAME & JET PIERCING

Bucyrus-Erie Co.
CARPCO MANUFACTURING, INC.
Linde Co. Union Carbide Corp.

DRILLS (ROCK), PERCUSSION, LARGE HOLE (+4-IN.), QUARRY & WELL

Acme Machinery Co.
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Bucyrus-Erie Co.
Cardox Corp. Hardsocg Div.
GARDNER DENVER CO.
HOFFMAN BROS. DRILLING CO.
INGERSOLL-RAND CO.
JOY MFG. CO.
Mayhew Machine & Supply Co.
Metal Carbides Corp.

MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
Stardrill-Keystone Co.
WESTINGHOUSE AIR BRAKE CO.
Worthington Corp.

DRILLS (ROCK) PERCUSSION, LARGE HOLE (+4-IN.), QUARRY & WELL "DOWN-THE-HOLE"

BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Bucyrus-Erie Co.
GARDNER DENVER CO.
HOFFMAN BROS. DRILLING CO.
INGERSOLL-RAND CO.
JOY MFG. CO.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
Stardrill-Keystone Co.
WESTINGHOUSE AIR BRAKE CO.
WINTER WEISS CO.
Worthington Corp.

DRILLS (ROCK), PERCUSSION, SMALL HOLE (—4-IN.)

Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Bucyrus-Erie Co.
CHICAGO PNEUMATIC TOOL CO.
GARDNER DENVER CO.
Hayes Steel Products, Ltd.
HOFFMAN BROS. DRILLING CO.
Holman Bros. - Canada Ltd.
HOSSFELD MFG. CO.
INGERSOLL-RAND CO.
JOY MFG. CO.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
SCHRAMM, INC.
Stardrill-Keystone Co.
Thor Power Tool Co.
WESTINGHOUSE AIR BRAKE CO.
Worthington Corp.

DRILLS (ROCK), ROTARY, LARGE HOLE (+4-IN.), QUARRY & WELL

Acker Drill Co.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
Bucyrus-Erie Co.
CHICAGO PNEUMATIC TOOL CO.
Davey Compressor Co.
Failing Co., George E.
GARDNER DENVER CO.
HOFFMAN BROS. DRILLING CO.
Industrial Overlay Metals, Inc.
INGERSOLL-RAND CO.
JOY MFG. CO.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
MOBILE DRILLING, INC.
REICH BROS. MFG. CO.
SCHRAMM, INC.
Stardrill-Keystone Co.
WESTINGHOUSE AIR BRAKE CO.
WINTER WEISS CO.
Worthington Corp.

DRILLS (ROCK), ROTARY, SMALL HOLE (—4-IN.)

Acker Drill Co.
Allegheny Ludlum Steel Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
Bucyrus-Erie Co.
Davey Compressor Co.
DIAMOND DRILL CONTRACTING CO.
Drilling Accessory & Mfg. Co., Inc.
Fletcher & Co., J. H.
GARDNER DENVER CO.
HOFFMAN BROS. DRILLING CO.
Industrial Overlay Metals, Inc.
INGERSOLL-RAND CO.
JOY MFG. CO.
Maschinenfabrik Rudolf Hausherr & Soehne GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
SCHRAMM, INC.
Seismograph Service Corp.
Star Expansion
Stardrill-Keystone Co.
WESTINGHOUSE AIR BRAKE CO.
WINTER WEISS CO.
Worthington Corp.

DRILLS (ROCK), ROTARY-PERCUSSION, SMALL HOLE (—4-IN.)

Atlas Copco Pacific, Inc.
Bucyrus-Erie Co.
CHICAGO PNEUMATIC TOOL CO.
Davey Compressor Co.
INGERSOLL-RAND CO.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
Star Expansion
Stardrill-Keystone Co.
Thor Power Tool Co.
WESTINGHOUSE AIR BRAKE CO.
Worthington Corp.

DRILLS (ROCK), SELF-CONTAINED POWER, PACK-PORTABLE

Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Cardox Corp, Hardsocg Div.
Davey Compressor Co.
DIAMOND DRILL CONTRACTING CO.
Drilling Accessory & Mfg. Co., Inc.
GARDNER DENVER CO.
Geophysical Instrument & Supply Co.
INGERSOLL-RAND CO.
JOY MFG. CO.
MOBILE DRILLING, INC.
New York Engineering Co.
Packsack Diamond Drills, Ltd.
Seismograph Service Corp.
Syntron Co.
WESTINGHOUSE AIR BRAKE CO.
Worthington Corp.

DRILL (ROCK) BITS, AUGER

Acker Drill Co.
Cardox Corp. Hardsocg Div.
Central Mine Equipment Co.
CHICAGO PNEUMATIC TOOL CO.
DIAMOND DRILL CONTRACTING CO.
Firth Sterling, Inc.
GARDNER DENVER CO.
Hawthorne, Inc., Herb J.
HOFFMAN BROS. DRILLING CO.
KENNAMETAL INC. MINING TOOL DIV.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
Metallurgical Products Dept. General Electric Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
Salem Tool Co.
Stardrill-Keystone Co.
VASCOLOY-RAMET CORP.
Worthington Corp.

DRILL (ROCK) BITS (& STEMS), CHURN

Bucyrus-Erie Co.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
Spang & Co.
Stardrill-Keystone Co.
Worthington Corp.

DRILL (ROCK) BITS, CORE

Acker Drill Co.
American Coldset Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CHICAGO PNEUMATIC TOOL CO.
CHRISTENSEN DIAMOND PRODUCTS CO.
Davey Compressor Co.
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
Drilling Accessory & Mfg. Co., Inc.
GARDNER DENVER CO.
HOFFMAN BROS. DRILLING CO.
JOY MFG. CO.
KENNAMETAL INC. MINING TOOL DIV.
LONGYEAR CO., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
SPRAGUE & HENWOOD, INC.
Star Expansion
Stardrill-Keystone Co.
Varel Mfg. Co.
WESTINGHOUSE AIR BRAKE CO.
Worthington Corp.

DRILL (ROCK) BITS, DIAMOND

Acker Drill Co.
American Coldset Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CHICAGO PNEUMATIC TOOL CO.
CHRISTENSEN DIAMOND PRODUCTS CO.
Davey Compressor Co.
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
Diamond Products, Inc.
DIAMOND TOOL RESEARCH CO., INC.
Drilling Accessory & Mfg. Co., Inc.
Havlick, J. L.
HOFFMAN BROS. DRILLING CO.
JOY MFG. CO.
Koebel Diamond Tool Co.
LONGYEAR CO., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
MOBILE DRILLING, INC.
Mott Core Drilling Co.
Packsack Diamond Drills, Ltd.
Pennsylvania Drilling Co.
SMIT & CO., ANTON
SMIT & SONS, INC., J. K.
Sprague & Henwood, Inc.
Stardrill-Keystone Co.
Varel Mfg. Co.
Wheel Truing Tool Co.

DRILL (ROCK) BITS, DIAMOND, RESETTING SERVICE

Acker Drill Co.
American Coldset Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CHRISTENSEN DIAMOND PRODUCTS CO.
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
Diamond Products, Inc.
DIAMOND TOOL RESEARCH CO., INC.
Drilling Accessory & Mfg. Co., Inc.
Havlick, J. L.
HOFFMAN BROS. DRILLING CO.
JOY MFG. CO.
Koebel Diamond Tool Co.
LONGYEAR CO., E. J.
Mayhew Machine & Supply Co.
McClintock Co., R. S.
Metal Carbides Corp.
Pennsylvania Drilling Co.
SPRAGUE & HENWOOD, INC.
Varel Mfg. Co.
Wheel Trucking Tool Co.

DRILL (ROCK) BITS, PERCUSSION

Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Bucyrus-Erie CO.
Firth Sterling, Inc.
GARDNER DENVER CO.
Hayes Steel Products, Ltd.
Holman Bros. - Canada Ltd.
INGERSOLL-RAND CO.
JOY MFG. CO.
KENNAMETAL INC. MINING TOOL DIV.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Mayhew Machine & Supply Co.
Metal Carbides Corp.
Minerals Engineering Co.
MOBILE DRILLING, INC.
Sanderson, Cyclon Drill Co.
Star Expansion
Stardrill-Keystone Co.
Thor Power Tool Co.
Throwaway Bit Corp.
VASCOLOY-RAMET CORP.
WESTERN ROCK BIT MFG. CO
WESTINGHOUSE AIR BRAKE CO.

DRILL (ROCK) BITS, ROTARY, ROLLER CONE

Acker Drill Co.
Central Mine Equipment Co.
CHICAGO PNEUMATIC TOOL CO.
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Firth Sterling, Inc.
HOFFMAN BROS. DRILLING CO.
Hughes Tool Co.
Industrial Overlay Metals, Inc.
LONGYEAR CO., E. J.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
Star Expansion
Stardrill-Keystone Co.
Varel Mfg. Co
WESTINGHOUSE AIR BRAKE CO.

DRILL (ROCK) BITS, ROTARY LARGE HOLE (+4-IN.), QUARRY & WELL (SPADE, PRONG, ETC.)

Acker Drill Co.
Cardox Corp. Hardsocg Div.
CHICAGO PNEUMATIC TOOL CO.
Davey Compressor Co.
Firth Sterling, Inc.
Hawthorne, Inc., Herb J.
HOFFMAN BROS. DRILLING CO.
Industrial Overlay Metals, Inc.
KENNAMETAL INC. MINING TOOL DIV.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
Reed Roller Bit Co.
Salem Tool Co.
Stardrill-Keystone Co.
Varel Mfg. Co.
WESTINGHOUSE AIR BRAKE CO.

DRILL, (ROCK) BITS, ROTARY, SMALL HOLE (—4-IN.) SPADE, PRONG, ETC.)

Acker Drill Co.
Allegheny Ludlum Steel Corp.
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Firth Sterling, Inc.
Hawthorne, Inc., Herb J.
HOFFMAN BROS. DRILLING CO.
Industrial Overlay Metals, Inc.
KENNAMETAL INC. MINING TOOL DIV.
Maschinenfabrik Rudolf Hausherr Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
Stardrill-Keystone Co.
Thor Power Tool Co.
Varel Mfg. Co.
VASCOLOY-RAMET CORP.
WESTINGHOUSE AIR BRAKE CO.

DRILL (ROCK) BIT & STEEL FORGING & HEAT TREATING FURNACES

Acme Machinery Co.
Bucyrus-Erie Co.
GARDNER DENVER CO.
HOFFMAN BROS. DRILLING CO.
INGERSOLL-RAND CO.
Sanderson Cyclone Drill Co.
Stardrill-Keystone Co.

DRILL (ROCK) BIT & STEEL FORGING HAMMERS

GARDNER DENVER CO.
INGERSOLL-RAND CO.

DRILL (ROCK) BIT & STEEL GRINDERS

Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Bitco, Inc.
Blount Co., J. G.
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Coeur d'Alene Hardware & Foundry Co.
GARDNER DENVER CO.
Holman Bros. - Canada Ltd.
INGERSOLL-RAND CO.
JOY MFG. CO.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
WESTERN ROCK BIT MFG. CO.

DRILL (ROCK) BIT — STEEL LATHES

INGERSOLL-RAND CO.

DRILL (ROCK) CORK BARRELS

Acker Drill Co.
American Coldset Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CHRISTENSEN DIAMOND PRODUCTS CO.
Davey Compressor Co.
DIAMOND DRILL CONTRACTING CO.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
HOFFMAN BROS. DRILLING CO.
JOY MFG. CO.
LONGYEAR CO., E. J.
Mayhew Machine & Supply Co.
Minerals Engineering Co.
Mobile Drilling Inc.
Mott Core & Drilling Co.
Pennsylvania Drilling Co.
Reed Roller Bit Co.
SPRAGUE & HENWOOD, INC.
Stardrill-Keystone Co.

DRILL (ROCK) DUST COLLECTORS (Small Hole Drills)

Acme Machinery Co.
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Ducon Inc.,
Failing Co., George E.
Hayes Steel Products, Ltd.
Holman Bros. - Canada Ltd.
INGERSOLL-RAND CO.
Fletcher & Co., J. H.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Spencer Turbine Co.
Thor Power Tool Co.

WESTINGHOUSE AIR BRAKE CO.

DRILL (ROCK) DUST COLLECTORS (QUARRY DRILLS)

Davey Compressor Co.
Ducon, Inc.
INGERSOLL-RAND CO.
Markley Dust Control System, Inc.
Mayhew Machine & Supply Co.
Spencer Turbine Co.

DRILL (ROCK) JUMBOS & WAGONS

Acme Machinery Co.
CHICAGO PNEUMATIC TOOL CO.
Coeur d'Alene Hardware & Foundry Co.
GARDNER DENVER CO.
Hayes Steel Products, Ltd.
INGERSOLL-RAND CO.
JOY MFG. CO.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
MAYO TUNNEL & MINE EQUIPMENT CO.
Minerals Engineering Co.
Rogers Iron Works Co.
SCHRAMM, INC.
Thor Power Tool Co.
WESTINGHOUSE AIR BRAKE CO.
WINTER WEISS CO.
Worthington Corp.

DRILL (ROCK) STEEL, DIAMOND

Acker Drill Co.
Bethlehem Pacific Coast Steel Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
CHRISTENSEN DIAMOND PRODUCTS CO.
CRUCIBLE STEEL CO. OF AMERICA
Diamond Drill Carbon Co.
DIAMOND DRILL CONTRACTING CO.
HOFFMAN BROS. DRILLING CO.
Hoyland Steel Co., Inc.
JOY MFG. CO.
Koebel Diamond Tool Co.
LONGYEAR CO., E. J.
Mayhew Machine & Supply Co.
Minerals Engineering Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
SPRAGUE & HENWOOD, INC.

DRILL (ROCK) STEEL, PERCUSSION

Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Steels, Ltd.
Bethlehem Pacific Coast Steel Corp.
Bitco, Inc.
Black's Machine Shop
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Coeur d'Alene Hardware & Foundry Co.
CRUCIBLE STEEL CO. OF AMERICA
GARDNER DENVER CO.
Hoyland Steel Co., Inc.
INGERSOLL-RAND CO.
JOY MFG. CO.
Marathon Coal Bit Co. Inc.
Minerals Engineering Co.
Sanderson Cyclone Drill Co.
Stardrill-Keystone Co.
Thor Power Tool Co.
WESTINGHOUSE AIR BRAKE CO.

DRILL (ROCK) STEEL, ROTARY LARGE HOLE (QUARRY & WELL)

Acker Drill Co.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CRUCIBLE STEEL CO. OF AMERICA
Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
HOFFMAN BROS. DRILLING CO.
Hoyland Steel Co., Inc.
INGERSOLL-RAND CO.
JOY MFG. CO.
Marathon Coal Bit Co. Inc.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
Sanderson Cyclone Drill Co.
SCHRAMM, INC.
Stardrill-Keystone Co.
WINTER WEISS CO.

DRILL (ROCK) STEEL, ROTARY SMALL HOLE

Acker Drill Co.
Atlas Copco Pacific, Inc.
Bethlehem Pacific Coast Steel Corp.
BOYLES BROS. DRILLING CO., LTD. (VANCOUVER)
CRUCIBLE STEEL CO. OF AMERICA
Davey Compressor Co.
DIAMOND DRILL CONTRACTING CO.
Drilling Accessory & Mfg. Co., Inc.
HOFFMAN BROS. DRILLING CO.
Hoyland Steel Co., Inc.
INGERSOLL-RAND CO.
JOY MFG. CO.
Marathon Coal Bit Co. Inc.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Mayhew Machine & Supply Co.
MOBILE DRILLING, INC.
Pennsylvania Drilling Co.
Sanderson Cyclone Drill Co.
SCHRAMM, INC.
Stardrill-Keystone Co.
Thor Power Tool Co.
Varel Mfg. Co.
WESTINGHOUSE AIR BRAKE CO.
WINTER WEISS CO.

DRILL (ROCK) STEEL COUPLINGS

Acme Machinery Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Bitco, Inc.
BOYLES BROS. DRILLING CO., LTD (VANCOUVER)
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
CRUCIBLE STEEL CO. OF AMERICA
DIAMOND DRILL CONTRACTING CO.
INGERSOLL-RAND CO.
JOY MFG. CO.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
Minerals Engineering Co.
Thor Power Tool Co.
WINTER WEISS CO.

DRILL (ROCK) SUPPORTS (COLUMNS, BARS, ETC.)

Atlas Copco Pacific, Inc.
Hayes Steel Products, Ltd.
INGERSOLL-RAND CO.
JOY MFG. CO.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Minerals Engineering Co.
Thor Power Tool Co.
WESTINGHOUSE AIR BRAKE CO.

(DRIVES, MECHANICAL POWER TRANSMISSION—see below; also see: Clutches; Couplings, Power Take-Offs; Gear Motors)

DRIVES, BELT

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Pulley Co.
American Rubber Mfg. Co.
Browning Mfg. Co.
Christian Engineers, J. D.
Continental Gin Co. Industrial Div.
Dodge Mfg. Corp.
Flexible Steel Lacing Co.
GATES RUBBER CO.
Graton & Knight Co. Inc.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Kanawha Mfg. Co.
LINK-BELT CO.
McNally Pittsburg Mfg. Corp.
NATIONAL IRON CO.
New York Belting & Packing Co.
Wood's Sons Co., T. B.
U. S. Rubber Co. Mechanical Goods Div.

DRIVES, CHAIN

Bartlett & Snow Co., C. O.
Browning Mfg. Co.
Chain Belt Co.
Christian Engineers, J. D.
Continental Gin Co. Industrial Div.
Dodge Mfg. Corp.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
McNally Pittsburg Mfg. Corp.
Morse Chain Co. A Borg-Warner Industry
NATIONAL IRON CO.
Ohio Gear Co.
Union Chain & Mfg. Co.
Voland & Sons, Inc.
Webb Co., Jervis B.
Whitney Chain Co.

DRIVES, FLUID

American Blower Div. American-Standard
Christian Engineers, J. D.
Clark Equipment Co. Transmission Div.
Dodge Mfg. Corp.
General Motors Corp. Allison Div.
LINK-BELT CO. DEPT. EMJ-57
Master Electric Co.
Oilgear Co.
Prime Mover Co.
Titeflex, Inc.
TWIN DISC CLUTCH CO.
Vickers Inc.

DRIVES, GEAR

Allis Co., Louis
American Pulley Co.
Bartlett & Snow Co., C. O.
Brown, Inc., David
Christian Engineers, J. D.
Cleveland Worm & Gear Co.
Cone-Drive Gears Div. Michigan Tool Co.
Continental Gin Co. Industrial Div.
DeLaval Steam Turbine Co.
FALK CORP.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machine Corp.
General Electric Co. Gear Motor & Transmission Components Dept.
General Motors Corp. Allison Div.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Kanawha Mfg. Co.
Lima Electric Motor Co.
LINK-BELT CO. DEPT. EMJ-57
Master Electric CO.
McNally Pittsburg Mfg. Corp.
NATIONAL IRON CO.
Ohio Gear Co.
Perkins Machine & Gear Co.
Philadelphia Gear Works
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Snow-Nabstedt Gear Corp.
Sterling Electric Motors, Inc.
Stimmel Winch Co., Inc.
Tool Steel Gear & Pinion Co.
TWIN DISC CLUTCH CO.
U. S. Electrical Motors, Inc.
Western Gear Corp.
Yuba Manufacturing Co.

DRIVES, GEAR, SHAFT-MOUNTED

Allis Co., Louis
American Pulley Co.
Christian Engineers, J. D.
Cone-Drive Gears Div. Michigan Tool Co.
Continental Gin Co. Industrial Div.
Dodge Mfg. Corp.
FALK CORP.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Kanawha Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Master Electric Co.
NATIONAL IRON CO.
Perkins Machine & Gear Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Tool Steel Gear & Pinion Co.
Yuba Manufacturing Co.

DRIVES, MAGNETIC & EDDY-CURRENT

Allis Co., Louis
Cutler-Hammer, Inc.
DINGS MAGNETIC SEPARATOR CO.
Eaton Mfg. Co.
Electric Machinery Mfg. Co.
Fawick Airflex Co., Inc.
Whitney Chain Co.

DRIVES, VARIABLE SPEED

Allis Co., Louis
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Blower Div. American-Standard
American Pulley Co.
Browning Mfg. Co.
Clark Equipment Co. Transmission Div.
Cleveland Worm & Gear Co.
Eaton Mfg. Co.
Electro Dynamic Div. General Dynamics Corp.
Foote Bros. Gear & Machine Corp.
Fuller Manufacturing Co.
General Electric Co. Apparatus Sales Div.
General Electric Co. Gear Motor & Transmission Components Dept.
General Motors Corp. Allison Div.
HEWITT-ROBINS, INC.
Lewellen Mfg. Co.
Lima Electric Motor Co.
LINK-BELT CO. DEPT. EMJ-57
Lovejoy Flexible Coupling Co.
Master Electric Co.
NATIONAL SUPPLY CO.
Oilgear Co.
Reeves Pulley Co., Div. Reliance Electric & Engineering Co.
Reliance Electric & Engineering Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.
Vickers Inc.
Webb Co., Jervis B.
Western Gear Corp.
Wood's Sons Co., T. B.
Worthington Corp.

(DRYERS—see below; also see: Classifiers; Filters; Heaters; Kilns; Screens, Electrically Heated)

DRYERS, HEATED DRUM

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Bartlett & Snow Co., C. O.
Bruning Co., Inc. Charles
Canadian Locomotive Co., Ltd.
COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO
DENVER EQUIPMENT CO.
General American Transportation Corp. Louisville Dryer Div.
GOULD CO., GORDON I.
Hack Engineering Co.
Hazmag m. b. H.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
IOWA MFG. CO.
Jeffery Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. DEPT. EMJ-57
NORDBERG MFG. CO.
Patterson Foundry & Machine Co.
Rockwell Co., W. S.
Simplicity System Co.
STEARNS ROGER MFG. CO.
Universal Dredge Mfg. Co.
Washington Machinery Co.

DRYERS, INFRA-RED

Binks Mfg. Co.
Booth Co.
Corning Glass Works
Fisher Scientific Co.
Jeffrey Mfg. Co.

DRYERS, VIBRATING PAN, ELECTRICALLY HEATED

Carrier Conveyor Corp.
Jeffrey Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Syntron Co.

DUST COLLECTORS & PRECIPITATORS —does not include: Classifiers, Cyclone, Dry; Drill (rock) Dust Collectors; Filters, Air; Scrubbers, Air & Waste Gas

American Air Filter Co., Inc.
American Blower Div. American-Standard
BUELL ENGINEERING CO.
Convair, Inc.
DIESEL ENERGY CORP.
Ducon, Inc.
Dustex Corp.
FLY ASH ARRESTOR CORP.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Hisey-Wolf Machine Co.
IOWA MFG. CO.
Johnson-March Corp.
JOY MFG. CO.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Kirk & Blum Mfg. Co.
Koppers Co., Inc. Metal Prod. Div.
Koppers Co. Inc.
Mahon Co., R. C.
Majac Inc.
McNally Pittsburg Mfg. Corp.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
MINE SAFETY APPLIANCES CO.
NORTHERN BLOWER CO.
Ogden Iron Works
Pangborn Corp.
Pioneer Engineering Div. Poor & Co. Inc.
Research-Cottrell, Inc.
Santa Fe Tank Div. Fluor Products Co.
Schneible Co., Claude B.
Sly Mfg. Co., W. W.
Standard Electrical Tool Co.
Stanley Co., Inc., William W.
U. S. Electrical Tool Co.
U. S. Hoffman Machinery Corp. Air Appliance Div.
Western Precipitation Corp.
Westinghouse Electric Corp. Sturtevant Div.
Wheelabrator Corp.

DUST SAMPLERS

Dustex Corp.
MINE SAFETY APPLIANCES CO.
Staplex Co. Air Sampler Div.
Western Precipitation Corp.

E

ELECTRICAL BRUSHES

Carbon Engineering Corp.
Carbone Corp.
General Electric Corp. Ind. Haulage Div.-Loco. & Car Equip. Divs.

Helwig Co.
Keystone Carbon Co.
National Carbon Co. Union Carbide Corp.
Northwestern Electric Co.
Ohio Carbon Co.
Pure Carbon Co.
Southern Carbon Brush Co.
Speer Carbon Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

ELECTRICAL CABLE—other than below

Alphaduct Wire & Cable Co.
American Brass Co.
American Steel & Wire Div. U. S. Steel Corp.
ANACONDA WIRE & CABLE CO.
Ansonia Wire & Cable Co.
Auto-Lite Battery Corp.
Chester Cable Corp.
Circle F Mfg. Co.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co.
Crescent Insulated Wire & Cable Co.
Essex Wire Corp. Paranite Wire & Cable Div.
Ettco Wire & Cable Corp.
GENERAL CABLE CORP.
General Electric Co. Construction Materials Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Kerite Co.
Machinery Center Inc.
National Electric Products Corp.
OKONITE CO.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
ROME CABLE CORP.
Simplex Wire & Cable Co.
Tennesse Coal & Iron Div. U. S. Steel Corp.
Walker Brothers
Western Insulated Wire Co.

ELECTRICAL CABLE, ARMORED

Aluminum Co. of America
American Steel & Wire Div. U. S. Steel Corp.
ANACONDA WIRE & CABLE CO.
Ansonia Wire & Cable Co.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Crescent Insulated Wire & Cable Co.
Essex Wire Corp. Paranite Wire & Cable Div.
Ettco Wir & Cable Corp.
GENERAL CABLE CORP.
General Electric Co. Construction Materials Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs
Graybar Elec Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Kerite Co.
Machinery Center Inc.
National Electric Products Crop. Gateway Center
OKONITE CO.
Phelps Dodge Copper Products Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rochester Ropes, Inc.
Rockbestos Products Corp.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
ROME CABLE CORP.
Simplex Wire & Cable Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Triangle Conduit & Cable Co., Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

ELECTRICAL CABLE, NON-METALLIC SHEATHED

Aluminum Co. of America
American Steel & Wire Div. U. S. Steel Corp.
ANACONDA WIRE & CABLE CO.
Ansonia Wire & Cable Co.
Auto-Lite Battery Corp.
Chester Cable Corp.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Crescent Insulated Wire & Cable Co.
Essex Wire Corp: Paranite Wire & Cable Div.
Ettco Wire & Cable Corp.
GENERAL CABLE CORP.
General Electric Co. Construction Materials Div.
Graybar Elec. Co., Inc.
Kerite Co.
National Electric Products Corp. Gateway Center
OKONITE CO.
Phelps Dodge Copper Products Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rockbestos Products Corp.
ROME CABLE CORP.
Simplex Wire & Cable Co.
Tennessee Coal & Iron Div. U. S. Steel Crop.
Triangle Conduit & Cable Co., Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Walker Brothers
Western Insulated Wire Co.

ELECTRICAL CABLE, TRAILING

Aluminum Co. of America
American Steel & Wire Div. U. S. Steel Corp.
ANACONDA WIRE & CABLE CO.
Ansonia Wire & Cable Co
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Crescent Insulated Wire & Cable Co.
GENERAL CABLE CORP.
General Electric Co. Construction Materials Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car quip. Divs
Graybar Elec. Co., Inc.
OKONITE CO.
Phelps Dodge Copper Products Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
ROME CABLE CORP.
Simplex Wire & Cable Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Triangle Conduit & Cable Co., Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Western Insulated Wire Co.

ELECTRICAL CABLE ACCESSORIES & FITTINGS

Aluminum Co. of America
ANACONDA WIRE & CABLE CO.
Anderson Mfg. Co., Albert & J. M.
Appleton Electric Co.
Auto-Lite Battery Corp.
Burndy Corp.
Electrical Fittings Corp.
Elreco Corp.
G. & W. Electric Specialty Co.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs
Graybar Elec. Co., Inc.
JOY MFG. CO.
Memco Engineering & Mfg. Co.
National Electric Products Corp. Gateway Center
Ohio Brass Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Powercraft Corp.
Pyle-National Co.
Rattan Mfg. Co.
Steel City Electric Co.
Thomas & Betts Co.

ELECTRICAL CABLE SPLICERS & VULCANIZERS

AMERICAN MINE DOOR CO.
Clark Controller Co.
Deltron Electric Products, Inc.
Flood City Brass & Elec. Co.
Irvington Div. Minnesota Mining & Mfg. Co.
JOY MFG. CO.
MINE SAFETY APPLIANCES CO.
Pickard Industries, Inc. Central Mine Supply Co., Div.

ELECTRICAL CONDUIT, RACEWAYS & FITTINGS—also see Pipe

American Brass Co.
Appleton Electric Co.
Byers Co., A. M.
Crouse Hinds Co.
Electrical Fittings Corp.
FLEXAUST CO.
Franklin Plastics Co.
GENERAL CABLE CORP.
General Electric Co. Construction Materials Div.
General Cable Corp.
Graybar Elec. Co., Inc.
Johns-Manville
Killark Electric Mfg. Co.
Line Material Industries McGraw-Edison Co.
National Electric Products Corp. Gateway Center
NATIONAL SUPPLY CO.
Parker Electrical Mfg. Co.
Pittsburgh Reflector Co.
Pyle-National Co.
Rattan Mfg. Co.
ROME CABLE CORP.
Steel City Electric Co.
Steelduct Co.
Thomas & Betts Co.
Triangle Conduit & Cable Co., Inc.
U. S. Rubber Co. Mechanical Goods Div.
V. V. Fittings Co.
Walker Brothers
Youngstown Sheet & Tube Co.

(ELECTRICAL CONTROLS—see Controls)

(ELECTRICAL INSULATING MATERIALS—see Insulating Materials, Electrical)

ELECTRIC BATTERIES, DRY & STORAGE

Auto-Lite Battery Corp.
Bowers Battery & Spark Plug Co.
Bright Star Industries
Burgess Battery Co.
C & D Batteries, Inc.
Carbone Corp.
Edison, Inc., T. A. Edison Storage Battery Div.
ELECTRIC STORAGE BATTERY CO. EXIDE INDUSTRIAL DIV.
Goodrich Co., B. F. Truck & Bus Tire Dept.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
K. W. Battery Co.
National Carbon Co. Union Carbide Corp.
Ray-O-Vac Co.
Yardney Electric Corp.

ELECTRIC BATTERY CHARGERS

Automatic Switch Co.
C & D Batteries, Inc.
Electric Specialty Co.
ELECTRIC STORAGE BATTERY CO. EXIDE INDUSTRIAL DIV.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip Divs
General Nuclear Corp.
Goodrich Co., B. F. Truck & Bus Tire Dept.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
Hertner Electric Co.
Hobart Bros. Co.
Hose-McCann Telephone Co.
Ironton Engine Co.
K. W. Battery Co.
Kersey Mfg. Co., Inc.
Knopp, Inc.
Lincoln Electric Co.
Marquette Mfg. Co., Inc.
Northwestern Electric Co.
Onan & Sons, Inc., D. W.
Quick Charge Inc.
Syntron Co.
Wincharger Corp.
Yardney Electric Corp.

ELECTRIC BATTERY TRANSFER RACKS

Graybar Elec. Co., Inc.

ELECTRIC GENERATORS—does not include engine or motor generator sets, see below or Rectifiers

ALLIS-CHALMERS MFG. CO. INDUSTRIES GROUP
Allis Co., Louis
Auto-Lite Battery Corp.
Century Electric Co.
Columbia Electric Mfg. Co.
Continental Electric Co., Inc.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Elliott Co.
Fairbanks, Morse & Co.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs.
Graybar Elec. Co. Inc.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Kurz & Root Co.
Leland Electric Co., Div. American Machine & Foundry Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Northwestern Electric Co.
Ohio Brass Co.
Onan & Sons, Inc., D. W.
Troy Engine & Machine Co.

ELECTRIC GENERATING POWER PLANTS, MOBILE & MOVABLE

Alco Products, Inc.
ALLIS-CHALMERS MFG. CO. BUDA DIV.
ALLIS-CHALMERS MFG. CO. INDUSTRIES GROUP
BABCOCK & WILCOX CO.
Beech Aircraft Corp.
Caterpillar Tractor Co.
CHICAGO PNEUMATIC TOOL CO.
Detroit Diesel Engine Div. General Motors Corp.
DIESEL ENERGY CORP.
Fairbanks, Morse & Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Hallett Diesel Engine Div. American M. A. R. C., Inc.
HARNISHFEGER CORP. P & H DIESEL DIV.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Kurz & Root Co.
Lister-Blackstone, Inc.
Marathon Electric Mfg. Corp.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Murphy Diesel Co.
NORDBERG MFG. CO.
Northwestern Electric Co.
Onan & Sons, Inc., D. W.
Pyle-National Co.
Ready Power Co.
Sheppard Co., Inc., R. H.
Thor Power Tool Co.
Universal Motor Co.
Waukesha Motor Co.
Westinghouse Electric Corp.
White Diesel Engine Div. White Motor Co.
Wincharger Corp.
Witte Engine Works, Oil Well Supply Div. U. S. Steel Corp.

ELECTRIC GENERATING POWER PLANTS, STATIONARY

Alco Products, Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
BABCOCK & WILCOX CO.
Caterpillar Tractor Co.
Condenser Service & Engineering Co.
Continental Electric Co., Inc.
Cooper-Bessemer Corp.
Detroit Diesel Engine Div. General Motors Corp.
DIESEL ENERGY CORP.
Fairbanks, Morse & Co.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Hallett Diesel Engine Div. American M. A. R. C., Inc.
Hertner Electric Co.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Lister-Blackstone, Inc.
NORDBERG MFG. CO.
Northwestern Electric Co.
Onan & Sons, Inc., D. W.
Pyle-National Co.
Ready Power Co.
Terry Steam Turbine Co.
Universal Motor Co.
Waukesha Motor Co.
Westinghouse Electric Corp.
White Diesel Engine Div. White Motor Co.
Wincharger Corp.
Witte Engine Works Oil Well Supply Div. U. S. Steel Corp.

ELECTRIC MOTORS—does not include Gear Motors

Acme Machinery Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Allis Co., Louis
Armor Electric Mfg. Co.
Auto-Lite Battery Corp.
Century Electric Co.
Cleveland Electric Motor Co.
Continental Electric Co., Inc.
Diehl Mfg. Co.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Electro Dynamic Div. General Dynamics Corp.
Fairbanks, Morse & Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Hertner Electric Co.
Howell Electric Motors Co.
Ideal Electric & Mfg. Co.
Imperial Electric Co.
Kato Engineering Co.
Kurz & Root Co.
Leland Electric Co., Div. American Machine & Foundry Co.
Lima Electric Motor Co.
Lincoln Electric Co.
Machinery Center Inc.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Northwestern Electric Co.
Ohio Electric Mfg. Co.
Peerless Electric Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Reliance Electric & Engineering Co.
Robbins & Myers, Inc.
Smith Co., A. O.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.

Wagner Electric Corp.
Western Gear Corp.
Westinghouse Electric Corp.
Wincharger Corp.

ELECTRIC MOTORS, PROTECTED

Acme Machinery Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Allis Co., Louis
Armor Electric Mfg. Co.
Baldor Electric Co.
Century Electric Co.
Cleveland Electric Motor Co.
Continental Electric Co., Inc.
Diehl Mfg. Co.
Electric Machinery Mfg. Co.
Electric Specialty Co.
Electro Dynamic Div. General Dynamics Corp.
Elliott Co.
Fairbanks, Morse & Co.
General Electric Co. Apparatus Sales Div.
Graybar Elec. Co., Inc.
Howell Electric Motors Co.
Ideal Electric & Mfg. Co.
Imperial Electric Co.
Kurz & Root Co.
Lima Electric Motor Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Northwestern Electric Co.
Ohio Electric Mfg. Co.
Peerless Electric Co.
Reliance Electric & Engineering Co.
Robbins & Myers, Inc.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.
Wagner Electric Corp.
Western Gear Corp.
Westinghouse Electric Corp.
Wincharger Corp.

ELECTRIC MOTOR CONTROLS—also see Controls

Acme Machinery Co.
Allen-Bradley Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Allis Co., Louis
Armor Electric Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Auto-Lite Battery Corp.
Automatic Switch Co.
Black & Decker Mfg. Co.
Bristol Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co. Div. Square D. Co.
Electric Materials Co.
Electrical Machinery Mfg. Co.
Ensign Electric & Mfg. Co.
Federal Pacific Electric Co.
Federal Pacific Electric Co. Pacific Switchgear Div.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Ideal Electric & Mfg. Co.
Kato Engineering Co.
Kurz & Root Co.
Machinery Center Inc.
Northwestern Electric Co.
Ohio Brass Co.
Parker Electrical Mfg. Co.
Pyle-National Co.
Reliance Electric & Engineering Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS, MECHANICAL

General Electric Co. Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Kersey Mfg. Co., Inc.

ELECTRIC RECTIFIERS, MERCURY ARC

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs.
Reliance Electric & Engineering Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS, MOTOR-GENERATOR SETS

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Allis Co., Louis
Continental Electric Co., Inc.
Electro Dynamic Div. General Dynamics Corp.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
General Motors Corp. Electro-Motive Div.
Ideal Electric & Mfg. Co.
Kersey Mfg. Co., Inc.
Kurz & Root Co.
Leland Electric Co., Div. American Machine & Foundry Co.
Marathon Electric Mfg. Corp.
Marble Card Electric Corp.
Master Electric Co.
Miehle Printing Press & Mfg. Co. Star-Kimble Motor Div.
Northwestern Electric Co.
Reliance Electric & Engineering Co.
Sangamo Electric Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS, SELENIUM & RARE METAL

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Rectifier Co.
Baldor Electric Co.
Clark Controller Co.
General Electric Co., Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs.
General Nuclear Corp.
Graybar Elec. Co., Inc.
K. W. Battery Co.
Kersey Mfg. Co., Inc.
Knopp, Inc.
Perkin Engineering Co.
Syntron Co.
WESTINGHOUSE AIR BRAKE CO.
Westinghouse Electric Corp.
Whiting Corp.

ELECTRIC RECTIFIERS, VACUUM TUBE (ELECTRONIC)

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Baldor Electric Co.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Reliance Electric & Engineering Co.
WESTINGHOUSE AIR BRAKE CO.
WESTINGHOUSE ELECTRIC CORP.

ELECTRIC RECTIFIERS, SYNCHRONOUS CONVERTER

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.—Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
Universal Dredge Mfg. Co.
Westinghouse Electric Corp.

ELECTRIC RECTIFIERS SPECIAL OR OTHER THAN ABOVE

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
CARPCO MANUFACTURING, INC.
Curtiss-Wright Corp. Electronics Div.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Northwestern Electric Co.
WESTINGHOUSE AIR BRAKE CO.

ELECTRIC SWITCHGEAR & SWITCHES—also see: Electrical brushes; Controls, Electrical; Meters, Electrical; Electric Trolley Accessories

Allen-Bradley Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Anderson Mfg. Co., Albert & J. M.
Arrow Hart & Hegeman Electric Co.
Automatic Switch Co.
Bethlehem Foundry & Machine Co.
Bulldog Electric Products Co.
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Circle F Mfg. Co.
Cutler-Hammer, Inc.
Delta-Star Electric Div. H. K. Porter Company, Inc.
Durakool, Inc.
Electronic Machinery Mfg. Co.
Federal Pacific Electric Co.
Federal Pacific Electric Co., Pacific Switchgear Div.
G. & W. Electric Specialty Co.
General Electric Co., Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.—Loco. & Car Equip. Divs
General Equipment & Mfg. Co.
General Switch Co., Div. Norbute Div.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Heinemann Electric Co.
I-T-E Circuit Breaker Co.
Ideal Electric & Mfg. Co.
Kolton Electric Mfg. Co.
Kurz & Root Co.
Lake Shore Electric Mfg. Corp.
Line Material Industries McGraw-Edison Co.
Memco Engineering & Mfg. Co.
Micro Switch Div.
NACHOD & U. S. SIGNAL CO.
NATIONAL FILTER MEDIA CORP.
Northwestern Electric Co.
Parker Electrical Mfg. Co.
Powercraft Corp.
V.V. Fittings Co.
Wadsworth Electric Mfg. Co.
Westinghouse Electric Corp.

ELECTRIC TRANSFORMERS—also see Unit Substations below

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Burton Equipment Co., Inc.
Eisler Engineering Co.
Federal Pacific Electric Co. Pacific Switchgear Div.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.—Loco. & Car Equip. Divs
Graybar Elec. Co., Inc.
Hevi-Duty Electric Co.
I-T-E Circuit Breaker Co.
Knopp, Inc.
Kolton Electric Mfg. Co.
Kuhlman Electric Co.
Line Material Industries McGraw-Edison Co.
Machinery Center Inc.
Moloney Electric Co.
Northwestern Electric Co.
Sangamo Electric Co.
Sorgel Electric Co
Standard Transformer Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

ELECTRIC TROLLEY ACCESSORIES

Anderson Mfg. Co., Albert & J. M.
Arizona Testing Laboratories
Charlton Laboratories
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Deltron Electric Products, Inc.
Duquesne Mine Supply Co.
Elreco Corp.
Flood City Brass & Elec. Co.
Forker Corp.
General Equipment & Mfg. Co.
Gering Products, Inc.
Hales Co., W. M.
NACHOD & U. S. SIGNAL CO.
NATIONAL FILTER MEDIA CORP.
Ohio Brass Co.
Root & Simpson, Inc.
Star Brass Works

ELECTRIC UNIT SUBSTATIONS

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Federal Pacific Electric Co.
Federal Pacific Electric Co. Pacific Switchgear Div.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.—Loco. & Car Equip. Divs
Graybar Elec. Co., Inc.
Hevi-Duty Electric Co.
I-T-E Circuit Breaker Co.
Kolton Electric Mfg. Co.
Kuhlman Electric Co.
Line Material Industries McGraw-Edison Co.
Memco Engineering & Mfg. Co.
Moloney Electric Co.
Sorgel Electric Co.
Standard Transformer Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

ELECTRIC VOLTAGE REGULATORS

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Allis Co., Louis
Auto-Lite Battery Corp.
Curtiss-Wright Corp. Electronics Div.
Electric Machinery Mfg. Co.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.—Loco. & Car Equip. Divs
Graybar Elec. Co., Inc.
Line Material Industries McGraw-Edison Co.
Moloney Electric Co.
Northwestern Electric Co.
Perkin Engineering Co.
Pyle-National Co.
Reliance Electric & Engineering Co.
Westinghouse Electric Corp.

ELEVATORS, PLANT BUILDINGS (MAN & MATERIAL)—does not include: Conveyors; Hoists

Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Hapman Conveyors, Inc.
O. K. Machinery Div. John C. Motter Printing Press Co.
Transport Trailers, Inc.
Westinghouse Electric Corp.

ENGINES, DIESEL

Alco Products, Inc.
ALLIS-CHALMERS MFG. CO. BUDA DIV.
ALLIS CHALMERS MFG. CO. CONSTRUCTION MACHY. DIV.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Atlas Copco Pacific, Inc.
Canadian Locomotive Co., Ltd.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
CHICAGO PNEUMATIC TOOL CO.
Compton, Inc.
Continental Motors Co.
Cooper-Bessemer Corp.
Cummins Engine Co., Inc.
Detroit Diesel Engine Div. General Motors Corp.
DIESEL ENERGY CORP.
Fairbanks, Morse & Co.
General Motors Corp. Electro-Motive Div.
Hallett Diesel Engine Div. American M.A.R.C., Inc.
HARNISCHFEGER CORP.
HARNISCHFEGER CORP. P & H DIESEL DIV.
INGERSOLL-RAND CO.
International Harvester Export Co.
Lister-Blackstone, Inc.
Machinery Center Inc.
Murphy Diesel Co.
NORDBERG MFG. CO.
Oliver Corp.
Onan & Sons, Inc., D. W.
Sheppard Co., Inc., R. H.
Waukesha Motor Co.
Witte Engine Works Oil Well Supply Div. U. S. Steel Corp.
White Diesel Engine Div. White Motor Co.
Worthington Corp.

ENGINES, GAS & GASOLINE

ALLIS CHALMERS MFG. CO. BUDA DIV.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Briggs & Stratton Corp.
Canadian Locomotive Co., Ltd.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
CHICAGO PNEUMATIC TOOL CO.
Climax Engine & Pump Mfg. Co.
Continental Motors Co.
DIESEL ENERGY CORP.
Fairbanks, Morse & Co.
Ford Motor Co.
International Harvester Export Co.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Mustang Motor Products Corp.
NORDBERG MFG. CO.
Oliver Corp.
Onan & Sons, Inc., D. W.
Reo Motors, Inc.
Waukesha Motor Co.
WESTINGHOUSE AIR BRAKE CO.
White Diesel Engine Div. White Motor Co.
Wisconsin Motor Corp.
Witte Engine Works Oil Well Supply Div. U. S. Steel Corp.

ENGINES, HYDRAULIC TURBINE

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Leffel & Co., James

ENGINES, STEAM

Condenser Service & Engineering Co.
Pyle-National Co.
Skinner Engine Co.
Troy Engine & Machine Co.

ENGINE EXHAUST SCRUBBERS

Drott Mfg. Co.
EIMCO CORP.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs.
International Harvester Export Co.
Landis Steel Co.

Robinson Ventilating Co.
Ruth Co.
Telluride Iron Works Co.

(EXCAVATORS—see below; also see: Dredges; Loaders; Monitors; Scrapers; Tractor Attachments; Buckets; Hoists; Winches)

EXCAVATORS, BUCKET WHEEL

Bucyrus-Erie Co.
Gar Wood Industries, Inc.

EXAVATORS, CLAM SHELL & GRAB BUCKET CRANE

American Hoist & Derrick Co.
AUSTIN-WESTERN WORKS CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Bucyrus-Erie Co.
Clark Equipment Co. Construction Machinery Div.
Drott Mfg. Co.
Gar Wood Industries, Inc.
Hyster Co.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.
Yaun Mfg. Co., Inc.

EXCAVATORS, DIPPER SHOVEL

American Hoist & Derrick Co.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co. Construction Machinery Div.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Pettibone Mulliken Corp.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

EXCAVATORS, DRAGLINE CRANE

American Hoist & Derrick Co.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co. Construction Machinery Div.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Page Engineering Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.
Yaun Mfg. Co., Inc.

EXCAVATORS, DRAGLINE TOWER

SAUERMAN BROS., INC.

EXCAVATORS, MOUNTED ON CRAWLERS

ALLIS CHALMERS MFG. CO. CONSTRUCTION MACHY. DIV.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Hoist & Derrick Co.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Caterpillar Tractor Co.
Clark Equipment Co. Construction Machinery Div.
Drott Mfg. Co.
EAGLE IRON WORKS
EIMCO CORP.
Gar Wood Industries, Inc.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Quick-Way Truck Shovel Co.
Sanford-Day Iron Works, Inc.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

EXCAVATORS, MOUNTED ON WHEELS

American Hoist & Derrick Co.
BALDWIN - LIMA - HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bucyrus-Erie Co.
Clark Equipment Co. Construction Machinery Div.
Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Maxi Corp.
Northwest Engineering Co.
Quick-Way Truck Shovel Co.
Sanford-Day Iron Works, Inc.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

EXCAVATORS, MOUNTED ON WALKING SHOES

Bucyrus-Erie Co.
Marion Power Shovel Co.
Page Engineering Co.

EXCAVATORS, POWERED BY DIESEL & GASOLINE ENGINE

American Hoist & Derrick Co.
BALDWIN - LIMA - HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bucyrus-Erie Co.
Clark Equipment Co. Construction Machinery Div.
EIMCO CORP.
Gar Wood Industries, Inc.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

EXCAVATORS, POWERED BY ELECTRIC MOTOR

American Hoist & Derrick Co.
BALDWIN - LIMA - HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bucyrus-Erie Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Schield Bantam Co.
Thew Shovel Co.

(EXPLORATION SERVICE—see Contractors)

(EXPLORATION EQUIPMENT—see: Surverying Equipment; Food, Packaged Kits; Tarpaulins; Geologist's Picks; Geophysical Instruments; Transits, Pocket)

(EXPLOSIVES—see Blasting Compounds)

F

FANS & BLOWERS, AIR & GAS

American Air Filter Co., Inc.
American Blower Div. American-Standard
American Machine & Metals, Inc. De Bothezat Fan Div.
Binks Mfg. Co.
Buffalo Forge Co.
Chelsea Fan & Blower Co.
Clarage Fan Co.
COPPUS ENGINEERING CO.
DeLaval Steam Turbine Co.
Diehl Mfg. Co.
Durlron Co., Inc.
FLY ASH ARRESTOR CORP.
Guyan Machy. Co.
Hartzell Propeller Fan Co.
Ilg Electric Ventilating Co.
INGERSOLL-RAND CO.
Jeffrey Mfg. Co.
JOY MFG. CO.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Koppers Co. Inc.
Lamson Corp.
Machinery Center Inc.
Martin Fan & Blower Co.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH c/o B. J. Nykerk Corp.
McNally Pittsburg Mfg. Corp.
Moore Co.
NORTHERN BLOWER CO.
Peerless Electric Co.
Robbins & Myers, Inc.
Robinson Ventilating Co.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Sanford-Day Iron Works, Inc.
Spencer Turbine Co.
Standard Elec. Mfg. Co., Inc.
U. S. Hoffman Machinery Corp. Air Appliance Div.
Western Gear Corp.
Westinghouse Electric Corp.
Westinghouse, Electric Corp. Sturtevant Div.
Wing Mfg. Co., L. J.

FASTENERS — SCREWS, BOLTS, NAILS, SPIKES, NUTS, WASHERS, ETC.—does not include: Rock & Roof Bolts; Timber Connectors

Ackerman-Johnson Co.
American Steel & Wir Div. U. S. Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Bristol Co.
Chicago Expansion Bolt Co.
Dicke Tool Co.
Dominion Steel & Coal Corp., Ltd.
Elastic Stop Nut Corp. of America
Frank, M. K.
General Steel Warehouse Co., Inc. Gensco Tool Div.
Gibraltar Equipment & Mfg. Co.
Lamson & Sessions Co.
Lewis Bolt & Nut Co.
Palnut Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pittsburgh Screw & Bolt Co.
PITTSBURGH STEEL CO.
Republic Steel Corp.
Rockford Bolt & Steel Co.
St. Louis Screw & Bolt Co.
Sawyer Belt Hook & Wedge Co., Inc.
Sheffield Div. Armco Steel Corp.
Star Expansion
Strong, Carlisle & Hammond Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.

(FEEDERS—see below; also see: Bin & Chute Gates & Mechanisms; Conveyors; Grizzlies; Screens)

FEEDERS, CHAIN (ROSS TYPE)

DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
IOWA MFG. CO.
LINK-BELT CO. DEPT. EMJ-57
ROSS SCREEN & FEEDER CO.

FEEDERS, CONSTANT WEIGHT & WEIGHING—also see Scales

BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
Dwight Lloyd Div. McDowell Co., Inc.
Erie Strayer Co.
HARDINGE CO., INC.
Industrial Physics & Electronics Co.
Jeffrey Mfg. Co.
Machinery Center Inc.
MERRICK SCALE MFG. CO.
McDowell Co., Inc.
OMEGA MACHINE CO., DIV. B-I-F INDUSTRIES
Richardson Scale Co.
SCHAFFER POIDOMETER CO.
Syntron Co.
Toledo Scale Co.
Wellman Engineering Co. McDowell Enterprise

FEEDERS, REAGENT, DRY

Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Fisher & Porter Co.
Infilco, Inc.
LINK-BELT CO. DEPT. EMJ-57
Jeffrey Mfg. Co.
Machinery Center Inc.
MORSE BROS. MACHINERY CO.
OMEGA MACHINE CO., DIV. B-I-F INDUSTRIES
Savage Co., W. J.
Syntron Co.

FEEDERS, REAGENT, LIQUID

American Water Softener Co.
Brosites Products Corp.
Clarkson Co.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Fisher & Porter Co.
GALIGHER CO.
Graver Water Conditioning Co.
Infilco, Inc.
Machinery Center Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Minerals Engineering Co.
MORSE BROS. MACHINERY CO.
OMEGA MACHINE CO., DIV. B-I-F INDUSTRIES

FEEDERS, RECIPROCATING PLUNGER

Acme Road Machinery Co., Inc.
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
Carrier Conveyor Corp.
DENVER EQUIPMENT CO.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
IOWA MFG. CO.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
McNally Pittsburg Mfg. Corp.
McLanahan & Stone Corp.
MORSE BROS. MACHINERY CO.
OMEGA MACHINE CO., DIV. B-I-F INDUSTRIES
Pioneer Engineering Div. Poor & Co., Inc.
Telluride Iron Works Co.
Universal Dredge Mfg. Co.

FEEDERS, REVOLVING DISK & PLATE

Allen-Sherman-Hoff Co.
Bartlett & Snow Co., C. O.
Birdsboro Steel Foundry & Machine Co.
Bodinson Manufacturing Co., Inc.
Bonded Scale & Machine Co.
Chain Belt Co.
Continental Gin Co. Industrial Div.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
HARDINGE CO., INC.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Infilco, Inc.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO.
MORSE BROS. MACHINERY CO.
NATIONAL IRON CO.
Pulva Corp.
Stephens-Adamson Mfg. Co.
Telluride Iron Works Co.

FEEDERS, ROTARY, DRUM

Deister Concentrator Co.
Deister Machine Co.
Hack Engineering Co.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
LINK-BELT CO. DEPT. EMJ-57
Specialty Engineering Co.
Universal Dredge Mfg. Co.
WESTERN MACHINERY CO.

FEEDERS, ROTARY, VANE

Allen-Sherman-Hoff Co.
Bartlett & Snow Co., C. O.
Continental Gin Co. Industrial Div.
Davis Foundry & Machine Works
Erie Strayer Co.
Fuller Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
LINK-BELT CO. DEPT. EMJ-57
Pulva Corp.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Wellman Engineering Co. McDowell Enterprise

FEEDERS, VIBRATING, SHAKING, ETC. (PLATE, TABLE, ETC.) does not include Grizzlies or Screens

Acme Road Machinery Co., Inc.
BALDWIN - LIMA - HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Branford Co.
CARPCO MANUFACTURING, INC.
Carrier Conveyor Corp.
Chain Belt Co.
Cleveland Vibrator Co.
Diamond Iron Works Div. Goodman Mfg. Co.
DRAVO CORP.
Hack Engineering Co.
HEWITT-ROBINS, INC.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
NATIONAL IRON CO.
Overstrom & Sons, Inc.
Prins & Associates, K.
Richardson Scale Co.
Ridge Equipment Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Savage Co., W. J.
SIMPLICITY ENGINEERING CO.
Smith Engineering Works
Specialty Engineering Co.
Syntron Co.
TRAYLOR ENGINEERING & MFG. CO.
Universal Dredge Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.

FENCING, METAL WIRE

American Chain & Cable Co., Inc.
American Steel & Wire Div. U. S. Steel Corp.
Bethlehem Steel Co., Inc.

Copperweld Steel Co.
PITTSBURGH STEEL CO.
Republic Steel Corp.
Sheffield Div. Armco Steel Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

FILTERS, AIR, GAS & DUST

American Air Filter Co., Inc.
Convair, Inc.
DIESEL ENERGY CORP.
Ducon, Inc
Goodyear Tire & Rubber Co. Industrial Products
Goodyear Tire & Rubber Co.
Hazemag m.b.H.
Koppers Co., Inc. Metal Prod. Div.
Leavitt Machine Co.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Mahon Co., R. C.
MINE SAFETY APPLIANCES CO.
NORTHERN BLOWER CO.
Pulmosan Safety Equipment Corp.
Purolator Products, Inc.
Sly Mfg. Co., W. W.
Staplex Co. Air Sampler Div.
Uehling Instrument Co.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.
Western Precipitation Corp.
WESTINGHOUSE AIR BRAKE CO IND PRODUCTS DIV.
Wheelabrator Corp.
Whiting Corp.
Wilkerson Corp.

FILTERS, CONCENTRATE

BIRD MACHINE CO.
BOOTH CO.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Duriron Co., Inc.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc.
GALIGHER CO.
Hirsch Bros. Machy. Co.
LINK-BELT CO. DEPT. EMJ-57
Machinery Center Inc.
MORSE BROS. MACHINERY CO.
Peterson Filters & Engr. Co.
Shriver & Co., T.

FILTERS, ENGINE OIL, ETC.

Buffalo Hammer Mill Corp.
Marvel Engineering Co.
Newark Wire Cloth Co.
Purolator Products, Inc.
Shriver & Co., T.
U. S. Hoffman Machinery Corp. Air Appliance Div.
Winslow Engineering & Mfg. Co.

FILTERS, WATER & LIQUID

American Water Softener Co.
Atlantic Tank Corp.
Bethlehem Pacific Coast Steel Corp.
BIRD MACHINE CO.
Brosites Products Corp.
Buffalo Hammer Mill Corp.
Cochrane Corp.
COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO.
Condenser Service & Engineering Co.
Duriron Co., Inc.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc.
Graver Water Conditioning Co.
Infilco, Inc.
Marvel Engineering Co.
Newark Wire Cloth Co.
Peterson Filters & Engr. Co.
Permutit Co.
Purolator Products, Inc.
Shriver & Co., T.
U. S. Hoffman Machinery Corp. Air Appliance Div.

FILTER BAGS

Albany Felt Co.
Bemis Bro. Bag Co.
Brosites Products Corp.
Dagley Mfg. Co.
Daniels, Inc., C. R.
Ducon, Inc.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc.
Koppers Co., Inc. Metal Prod. Div.
National Filter Media Corp.
NORTHERN BLOWER CO.
Pendleton Woolen Mills
Peterson Filters & Engr. Co.
Safety Clothing & Equipment Co.
Shriver & Co., T.
Sly Mfg. Co., W. W.
Stanley Co., Inc., William W.

FILTER CLOTH

Albany Felt Co.
Bemis Bro. Bag Co.
Brosites Products Corp.
Buffalo Wire Works Co.
Dagley Mfg. Co.
Daniels, Inc., C. R.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc.
House & Sons, Inc. Chas. W.
Ludlow-Saylor Wire Cloth Co.
Multi-Metal Wire Cloth Co., Inc.
National Filter Media Corp.
Newark Wire Cloth Co.
Pendleton Woolen Mills
Peterson Filters & Engr. Co.
Shriver & Co., T.
Sly Mfg. Co., W. W.
Stanley Co., Inc., William W.
Tyler Co., W. S.
U S. Rubber Co.
Wellington Sears Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Wilkerson Corp.

FILTER MEDIA (OTHER THAN BAGS & CLOTH

American Air Filter Co., Inc.
American Water Softener Co.
Brosites Products Corp.
Condenser Service & Engineering Co.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
Duriron Co., Inc.
EIMCO CORP.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc.
Graver Water Conditioning Co.
Johns-Manville
Koppers Co., Inc. Metal Prod. Div.
Marvel Engineering Co.
MINE SAFETY APPLIANCES CO.
Multi-Metal Wire Cloth Co., Inc.
National Filter Media Corp.
Norton Co.
Peterson Filters & Engr. Co.
Pettinos, Inc., George F.
Shriver & Co., T.

FIRE FIGHTING EQUIPMENT & SUPPLIES

Acme Rubber Mfg. Co.
Bullard Co., E. D.
Daniels, Inc., C. R.
Eastman-Pacific Co.
Elkhart Brass Mfg. Co., Inc.
Falcon Alarm Co., Inc.
Four Wheel Drive Auto Co.
Fyr-Fyter Co.
Gatke Corp.
Goodrich Industrial Products Co., B. F.
GRINNELL CO., INC.
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Kidde & Co., Inc., Walter
Pickard Industries, Inc.
Porto Pump Inc.
Pulmosan Safety Equipment Corp.
Quaker Rubber Div. H. K. Porter Co.
Scott Aviation Corp.
Snyder & Son, Inc., M. L.
Stop-Fire, Inc.
U. S. Rubber Co.

FIRST AID EQUIPMENT & SUPPLIES

Bullard Co., E. D.
MINE SAFETY APPLIANCES CO.
Pulmosan Safety Equipment Corp.
Safety Clothing & Equipment Co.
Scott Aviation Corp.

(FLOCCULATING AGENTS—see Water Clarification Chemicals)

FLOOD LIGHTS, CARBIDE

Linde Co. Union Carbide Corp.

FLOOD LIGHTS, ELECTRIC—also see Lighting Fixtures & Lamps

Appleton Electric Co.
Crouse Hinds Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Ind. Haulage Div.-Loco. & Car Equip. Divs
JOY MFG. CO.
Line Material Industries McGraw-Edison Co.
MINE SAFETY APPLIANCES CO.
Multi Electrical Mfg. Co.
Phoenix Metal Products Co.
Pittsburgh Reflector Co.
Pyle-National Co.
Steber Mfg. Co.
Westinghouse Electric Corp.

FLOTATION MACHINES

BOOTH CO.
Canadian Locomotive Co., Ltd.
Chain Belt Co.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
GALIGHER CO.
Graver Water Conditioning Co.
Infilco Inc.
Machinery Center Inc.
MORSE BROS. MACHINERY CO.
National Tank & Pipe Co.
STEARNS ROGER MFG. CO.
U. S. Hoffman Machinery Corp.
WESTERN MACHINERY CO.

FLOTATION REAGENTS

AMERICAN CYANAMID CO. MINING CHEMICALS DEPT.
Armour & Co.
Canadian Industries Ltd.
Dewey & Almy Chemical Co., Div. W. R. Grace & Co.
Dow Chemical Co.
DuPont de Nemours & Co., E. I.
Emery Industries, Inc.
General Chemical Div. Allied Chemical & Dye Corp. Baker & Adamson Products
General Mills, Inc.
HERCULES POWDER CO.
Heyden Newport Chemical Corp.
Marathon Corp. Chemical Sales Dept.
Oronite Chemical Co.
Pacific Lumber Co.
Philadelphia Quartz Co.
Reilly Tar & Chemical Corp.
Stein, Hall & Co., Inc.
Union Carbide Chemicals Co. Union Carbide Corp.
West End Chemical Co.

(FLOTATION REAGENT FEEDERS—see Feeders)

FOOD, PACKAGED KITS

BOLTON FARM PACKING CO., INC.

FORGES, BLACKSMITH, ETC.

Calumet Div. Calumet & Hecla, Inc.
Spang & Co.
Stardrill-Keystone Co.

FORGINGS, DROP, ET AL

Alco Products, Inc.
Aluminum Co. of America
American Brake Shoe Co.
American Car & Foundry Div. ACF Industries, Inc.
Atlas Steels, Ltd.
Bethlehem Pacific Coast Steel Corp.
Columbus Forge & Iron Co.
Conley Frog & Switch Co.
CRUCIBLE STEEL CO. OF AMERICA
Duff Norton Co.
Duquesne Mine Supply Co.
Endicott Forging & Mfg. Co.
American Forge Co.
Giant Grip Mfg. Co.
Hayes Steel Products, Ltd.
Interstate Drop Forge Co.
Ladish Co.
Moore Drop Forging Co.
Mueller Brass Co.
NATIONAL SUPPLY CO.
New Departure Div., General Motors Corp.
Ohio Forge & Machine Corp.
Revere Copper & Brass, Inc.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Ryerson & Son, Inc., Joseph T.
Skookum Co., Inc.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Titan Metal Mfg. Co.
Webb Co., Jervis B.

FREEZEPROOFING MATERIALS—does not include Concrete Additives

International Salt Co.
Morton Salt Co.
U. S. Rubber Co.

FURNACES, INDUSTRIAL PROCESS, COMBUSTION HEATED (HEATING, MELTING, ROASTING, SMELTING, CERAMIC, METALLURGICAL, REFRACTORY, ETC.)—does not include: Boilers; Dryers; Heaters; Laboratory Equipment; Retorts; Sintering Equipment; also see below and: Kilns, Converters

AROS ELECTRIC, INC.
Denver Fire Clay Co.
DIESEL ENERGY CORP.
ELEKTROKEMISK A. S.
General Electric Co., Apparatus Sales Div.
Harper Electric Furnace Corp.
Hevi-Duty Electric Co.
Lectromelt Furnace Co. Div. McGraw Electric Co.
Leeds & Northrup Co.
Rockwell Co., W. S.
Whiting Corp.

FURNACES, INDUSTRIAL PROCESS, FLUIDIZED SOLIDS

DIESEL ENERGY CORP.
Dorr Oliver, Inc.
General Electric Co. Apparatus Sales

(FURNACES, INDUSTRIAL PROCESS, ROTARY—see: Converters; Kilns)

FURNACES, INDUSTRIAL PROCESS, SHAFT (BLAST, CUPOLA, ETC.)

COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO
DIESEL ENERGY CORP.
Denver Fire Clay Co.
MACE CO.
Pollock Co., William B.
Whiting Corp.

FURNACES, SHOP & BENCH (HEAT TREATING, MELTING, FORGING, ETC.)—also see: Drill (Rock) Bit & Steel Forging & Heat Treating Furnaces; Forges; does not include Laboratory Equipment

Bigelow-Liptak Corp.
Blue M Electric Co.
Denver Fire Clay Co.
Hevi-Duty Electric Co.
General Electric Co. Apparatus Sales
Rockwell Co., W. S.
U. S. Smelting Furnace Co.

FURNACES, SMELTING AND ROASTING

Bethlehem Foundry & Machine
Bigelow Liptak
COLORADO IRON WORKS CO.
Dorr-Oliver, Inc.
ELEKTROKEMISK A.S.
GOULD, GORDON I.
Lectromelt Furnace Co. Div. McGraw Electric Co.
MACE CO.
NICHOLS ENGINEERING & RESEARCH
Pacific Foundry Co. Ltd.
Salem-Brosius, Inc.
STEARNS-ROGER MFG. CO.
Treadwell Co., M. H.
U. S. Smelting Furnace Co.
Whiting Corp.

FURNACE CHARGERS

Whiting Corp.

FURNACE LININGS, WALLS & ARCHES —also see Refractories

BABCOCK & WILCOX CO.
Bigelow-Liptak Corp.
Denver Fire Clay Co.
Electro Refractories & Abrasives Corp.
GENERAL REFRACTORIES, CO.
Green Fire Brick Co., A. P.
Ironton Fire Brick Co.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
Norton Co.
Pettinos, Inc., George F.
Quigley Co., Inc.
Refractory & Insulation Corp.
Reintjes Co., George P.
STEARNS ROGER MFG. CO.

G

(GAGES—see Meters)

(GALVANOMETERS—see Meters, Electricity)

GAS (& HUMIDITY) DETECTORS & INDICATORS—also see Meters, Chemical

American Instrument Co., Inc.
Baker & Co., Inc.
Brabender Corp.
Bristol Co.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Curtiss-Wright Corp. Electronics Div.
Fisher & Porter Co.
General Electric Co. Apparatus Sales Div.
MINE SAFETY APPLIANCES CO.
Taller & Cooper, Inc.

GAS GENERATORS

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
Baker & Co., Inc.

General Electric Co. Apparatus Sales Div.
Hevi-Duty Electric Co.
Industrial Air Products Co.
Linde Co. Union Carbide Corp.
National Cylinder Gas Co.
Sight Feed Generator Co.

GAS SEPARATION PROCESS EQUIPMENT (SPECIAL)—does not include Dust Collectors or standard auxiliary equipment

Baker & Co., Inc.
Black, Sivalls & Bryson, Inc.
Graver Tank & Mfg. Co., Inc.
Process Engineering, Inc.
Standard Steel Corp.

GASKETS

Belmont Packing & Rubber Co.
Belmont Smelting & Refining Works, Inc
Chase Brass & Copper Co.
Felt Products Mfg. Co.
Gatke Corp.
Goodall Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Goodyear Tire & Rubber Co.
Greene, Tweed & Co.
Hales Co., W. M.
Hayes Steel Products, Ltd.
HEWITT-ROBINS, INC.
Johns-Manville
Metallo Gasket Co.
National Vulcanized Fibre Co.
New York Belting & Packing Co.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Snyder & Son, Inc., M. L.
U. S. Rubber Co.

GEAR MOTORS—Also see: Drives; Electric Motors

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Allis Co., Louis
Brown, Inc., David
Century Electric Co.
Christian Engineers, J. D.
Cone-Drive Gears Div. Michigan Tool Co.
Electro Dynamic Div., General Dynamics Corp.
Elliott Co.
Fairbanks, Morse & Co.
FALK CORP.
Foote Bros. Gear & Machine Corp.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs
Howell Electric Motors Co.
LINK-BELT CO. DEPT. EMJ-57
Marble Card Electric Corp.
Master Electric Co.
Northwestern Electric Co.
Ohio Gear Co.
Philadelphia Gear Works
Reliance Electric & Engineering Co.
Sterling Electric Motors, Inc.
U. S. Electrical Motors, Inc.
Western Gear Corp.
Westinghouse Electric Corp.

(GEAR PULLERS—see Car Wheel & Gear Pullers)

GEARS & PINIONS, METAL—also see below

Acme Road Machinery Co., Inc.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Ampco Metal, Inc.
Brad Foote Gear Works, Pittsburgh Gear Co. Div.
Brown, Inc., David
Christian Engineers, J. D.
Clark Equipment Co. Transmission Div.
CRUCIBLE STEEL CO. OF AMERICA
Cullman Wheel Co.
Davis Foundry & Machine Works
Eaton Mfg. Co.
FALK CORP.
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Foote Bros. Gear & Machine Corp.
Frog, Switch & Mfg. Co.
General Electric Co. Gear Motor & Transmission Components Dept.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co
Kanawha Mfg Co
Kensington Steel Co
LINK-BELT CO. DEPT. EMJ-57
Marathon Coal Bit Co. Inc.
Massachusetts Gear & Tool Co.
McNally Pittsburg Mfg. Corp.
Ogden Iron Works
Ohio Gear Co.
Olds Alloy Co.
Penn Machine Co.
Perkins Machine & Gear Co.
Philadelphia Gear Works
Pittsburgh Gear Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Specialty Engineering Co.
Stahl Gear & Machine Co.
STEARNS ROGER MFG. CO.
Stroh Process Steel Co.
Tool Steel Gear & Pinion Co.
Vulcan Iron Works
West Virginia Armature Co.
Western Gear Corp.
Westinghouse Electric Corp.
Whitney Chain Co.

GEARS & PINIONS, METAL, LARGE (BALLMILL, MINESHAFT HOIST, ET AL)

Ampco Metal, Inc.
Birdsboro Steel Foundry & Machine Co.
Brad Foote Gear Works Pittsburgh Gear Co. Div.
Brown, Inc., David
CRUCIBLE STEEL CO. OF AMERICA
Davis Foundry & Machine Works
DeLaval Steam Turbine Co.
FALK CORP.
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Foote Bros. Gear & Machine Corp.
Frog, Switch & Mfg. Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Kanawha Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Ohio Gear Co.
Olds Alloy Co.
Philadelphia Gear Works
Pittsburgh Gear Co.
Sorel Steel Foundries, Ltd.
Stahl Gear & Machine Co.
STEARNS ROGER MFG. CO.
Stroh Process Steel Co.
Tool Steel Gear & Pinion Co.
Vulcan Iron Works
West Virginia Armature Co.
Western Gear Corp.
Westinghouse Electric Corp.

GEARS & PINIONS, NON-METALLIC

Brad Foote Gear Works Pittsburgh Gear Co. Div.
Continental-Diamond Fibre Corp. A Subsidiary of Budd Co.
Foote Bros. Gear & Machine Corp.
Gatke Corp.
Hirsch Bros. Machy. Co.
Massachusetts Gear & Tool Co.
Menlo Research Laboratory
National Vulcanized Fibre Co.
Ohio Gear Co.
Perkins Machine & Gear Co.
Philadelphia Gear Works
Pittsburgh Gear Co.
Stahl Gear & Machine Co.
Synthane Corp.
West Virginia Armature Co.
Western Gear Corp.

(GEIGER COUNTERS—see Radiation Detectors)

GEOLOGIST'S PICKS

Fisher Research Laboratory, Inc.
Geophysical Instrument & Supply Co.

GEOPHYSICAL INSTRUMENTS — does not include: Radiation Detectors; Ultra-violet Lights

American Paulin System
Detectron Corp.
Engineers Syndicate, Ltd.
Failing Co., George E.
Fisher Research Laboratory, Inc.
Geo-Optic Co., Inc.
Geophysical Instrument & Supply Co.
Goldak Co., Inc.
Jarrell-Ash Co.
McPhar Geophysics, Ltd.
McPhar Manufacturing, Ltd.
Mt. Sopris Instument Co.
Seismograph Service Corp.
Southwestern Industrial Electronics Co.
Spartan Air Services
Sprengnether Instrument Co., Inc., W. F.
Texas Instruments, Inc. Industrial Instrumentation Div.
Universal Atomics Div. Universal Transistor Products Corp.
Ultra-Violet Products, Inc.

GRADERS, ROAD, TOWED & SELF-PROPELLED

ALLIS CHALMERS MFG. CO. CONSTRUCTION MACHY. DIV.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
AUSTIN-WESTERN WORKS CONSTRUCTION EQUIPMENT DIV. BADWIN-LIMA-HAMILTON CORP.
Caterpillar Tractor Co.
Gallon Iron Works
LE TOURNEAU-WESTINGHOUSE CO.
Pettibone Mulliken Corp.
WESTINGHOUSE AIR BRAKE CO.

GRATINGS, FLOOR

Bates Co., Walter
Borden Metal Products Co.
DRAVO CORP.
Hendrick Mfg. Co.
Irving Subway Grating Co., Inc.
Klemp Metal Grating Corp.
Laubenstein Mfg. Co.
Ryerson & Son, Inc., Joseph T.

(GRINDERS & BUFFERS—see below; also see: Drill (Rock) Bit & Steel Grinders)

GRINDERS & BUFFERS, ELECTRIC

Baldor Electric Co.
Black & Decker Mfg. Co.
Blount Co., J. G.
CHICAGO PNEUMATIC TOOL CO.
Cincinnati Electrical Tool Co.
Fisher Scientific Co.
Hisey-Wolf Machine Co.
INGERSOLL-RAND CO.
Lippmann Engineering Works, Inc.
Milwaukee Electric Tool Corp.
Queen City Machine Tool Co.
Ryerson & Son, Inc., Joseph T.
Standard Electrical Tool Co.
Stanley Electric Tools Div. Stanley Works
Thor Power Tool Co.
U. S. Electrical Tool Co.

GRINDERS & BUFFERS, PNEUMATIC

Atlas Copco Pacific, Inc.
CHICAGO PNEUMATIC TOOL CO.
GARDNER DENVER CO.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Reed Roller Bit Co.
Stoody Co.
Thor Power Tool Co.

GRINDING (& CUTTING) WHEELS

American Emery Wheel Works
American Coldset Corp.
Atlas Copco Pacific, Inc.
Bay State Abrasive Products Co.
Chicago Wheel & Mfg. Co.
Electro Refractories & Abrasives Corp.
Macklin Co.
Norton Co.
Peninsular Grinding Wheel Div.
Precision Grinding Wheel Co., Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Ryerson & Son, Inc., Joseph T.
Sterling Grinding Wheel Co.
Thor Power Tool Co.
U. S. Rubber Co. Mechanical Goods Div.
Waltham Grinding Wheel Co.

GRIZZLIES, FEEDING & MOVING

Acme Road Machinery Co., Inc.
Davis Foundry & Machine Works
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
IOWA MFG. CO.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. DEPT. EMJ-57
McLanahan & Stone Corp.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NORDBERG MFG. CO.
Rogers Iron Works Co.
ROSS SCREEN & FEEDER CO.
SIMPICITY ENGINEERING CO.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Syntron Co.
Telluride Iron Works Co.
TRAYLOR ENGINEERING & MFG. CO.
Universal Engineering Corp.
Washington Machinery Co.

GRIZZLIES, STATIONARY

Acme Road Machinery Co., Inc.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
BALDWIN - LIMA - HAMILTON CORP. CONSTRUCTION EQUIPMENT DIV.
Bodinson Manufacturing Co., Inc.
CARD IRON WORKS, C. S.
Colorado Fuel & Iron Corp.
Davis Foundry & Machine Works
Diamond Iron Works Div. Goodman Mfg. Co.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Kenyon Walker Machinery Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
MORSE BROS. MACHINERY CO.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Ogden Iron Works
Pioneer Engineering Div. Poor & Co. Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Telluride Iron Works Co.
TRAYLOR ENGINEERING & MFG. CO.
Universal Engineering Corp.
Universal Road Machinery Co.
Washington Machinery Co.
Yuba Manufacturing Co.

(GROUT PUMPS—see Concrete)

H

HARDFACING ALLOYS & RODS—also see: Metallizing; Welding

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
All-State Welding Alloys Co., Inc.
Alloy Rods Co.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Brake Shoe Co.
American Chain & Cable Co., Inc.
Ampco Metal, Inc.
Coast Metals, Inc.
CRUCIBLE STEEL CO. OF AMERICA
Hales Co., W. M.
Haynes Stellite Co. Div. Union Carbide Corp.
Hobart Bros. Co.
Industrial Air Products Co.
Industrial Overlay Metals, Inc.
KENNAMETAL INC. MINING TOOL DIV.
Lincoln Electric Co.
Marquette Mfg. Co., Inc.
Metal & Thermit Corp.
Minerals Engineering Co.
National Cylinder Gas Co.
Norton Co.
Rankin Manufacturing Co.
Resisto-Loy Co., Inc.
Shwayder Chemical Metallurgy Corp.
Sight Feed Generator Co.
Stulz-Sickles Co.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.

(HEATERS—see below; also see: Boilers, Dryers; Furnaces; Kilns; Retorts; Screen Heaters)

HEATERS, PROCESS, AIR & GAS (PRE-HEATERS, RECOUPERATORS, RE-GENERATORS, ETC.)

Bigelow-Liptak Corp.
Carbone Corp.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Salem-Brosius, Inc.

HEATERS, SPACE—does not include: Boilers; Furnaces; Kilns

Acme Electric Heating Co.
American Air Filter Co., Inc.
American Blower Div. American-Standard
Buffalo Forge Co.
Carrier Corp.
Cutler-Hammer, Inc.
Daniels, Inc., C. R.
DRAVO CORP.
General Electric Co. Apparatus Sales Div.
GRINNELL CO., INC.
Guyan Machy Co.
Indiana Foundry Co.
Vulcan Electric Co.
Westinghouse Electric Corp. Sturtevant Div.
Wing Mfg. Co., L. J.

(HEAT EXCHANGERS—see Boilers; Heaters; Coolers)

(HEAVY MEDIA SEPARATORS—see Separators, Heavy Media)

(HOISTS—see below; refer to Winches for type of power; also see: Cranes; Winches)

HOISTS, DREDGE, CRANE & SHOVEL TYPES

American Hoist & Derrick Co.
AUSTIN-WESTERN WORKS CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Clyde Iron Works, Inc.
HARNISCHFEGER CORP.
Hyster Co.

Koehring Co.
Lidgerwood Industries, Inc.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Reading Crane & Hoist Corp.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Superior-Lidgerwood-Mundy Corp.
Wiley Mfg. Co.
Yuba Manufacturing Co.

HOISTS, DRAGLINE SCRAPER-SLUSHER

American Hoist & Derrick Co.
GARDNER DENVER CO.
INGERSOLL-RAND CO.
JOY MFG. CO.
Lidgerwood Industries, Inc.
Marion Power Shovel Co.
O. K. Machinery Div. John C. Motter Printing Press Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
SAUERMAN BROS., INC.
VULCAN IRON WORKS CO., (DENVER)

HOISTS, LIFT, HAND CHAIN

American Chain & Cable Co., Inc. Wright Hoist Div.
Chisholm-Moore Hoist Div. Columbus McKinnon Chain Corp.
Chester Hoist Div. National Screw Mfg. Co.
Coffing Hoist Div. Duff-Norton Co.
Conco Engineering Works
DENVER EQUIPMENT CO.
Duff Norton Co.
Forker Corp.
Graybar Elec. Co., Inc.
Hales Co., W. M.
Harrington Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Reading Crane & Hoist Corp.
Robbins & Meyers, Inc.
Round & Son, Inc., David
Ryerson & Son, Inc., Joseph T.
Yale & Towne Mfg. Co. Yale Materials Handling Div.

HOISTS, LIFT, PORTABLE & MOVEABLE—does not include Hoists, Lift, Hand Chain.

American Chain & Cable Co., Inc. Wright Hoist Div.
American Pulley Co.
CHICAGO PNEUMATIC TOOL CO.
Clyde Iron Works, Inc.
Coffing Hoist Div. Duff-Norton Co.
Conco Engineering Works
Construction Machy. Co.
DENVER EQUIPMENT CO.
Detroit Hoist & Machine Co.
Duff-Norton Co.
Electro Lift, Inc.
Forker Corp.
Gripholst, Inc.
Harrington Co.
Hyster Co.
INGERSOLL-RAND CO.
JOY MFG. CO.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
O. K. Machinery Div. John C. Motter Printing Press Co.
Princeton Gripholst, Inc.
Ryerson & Son, Inc., Joseph T.
Silent Hoist & Crane Corp.
Templeton, Kenly & Co.
Thor Power Tool Co.
Yale & Towne Mfg. Co. Yale Materials Handling Div.

HOISTS, LIFT, STATIONARY

American Hoist & Derrick Co.
Anthony Co.
Atlas Copco Pacific, Inc.
Bartlett & Snow Co., C. O.
Clyde Iron Works, Inc.
Conco Engineering Works
Curtis Manufacturing Co.
Electro Lift, Inc.
GARDNER DENVER CO.
Harrington Co.
INGERSOLL-RAND CO.
JOY MFG. CO.
Joyce-Cridland Co.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
NATIONAL IRON CO.
Novo Pump & Engine Co.
Ryerson & Son, Inc., Joseph T.
SAUERMAN BROS., INC.
Shepard Niles Crane & Hoist Corp.
Silent Hoist & Crane Corp.
Superior-Lidgerwood-Mundy Corp.

HOISTS, MINE SHAFT DRUM—does not include: Sheaves; Skips & Cages; Buckets

Clyde Iron Works, Inc.
GARDNER DENVER CO.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
INGERSOLL-RAND CO.
JOY MFG. CO.
Lake Shore, Inc. Lake Shore Engineering Div.
Lidgerwood Industries, Inc.
Machinery Center Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
NORDBERG MFG. CO.
Rogers Iron Works Co.
Shepard Niles Crane & Hoist Corp.
STEARNS ROGERS MFG. CO.
Superior-Lidgerwood-Mundy Corp.
VULCAN IRON WORKS CO., (DENVER)
Vulcan Iron Works

HOISTS, MINE SHAFT FRICTION—does not include: Sheaves, Skips & Cages; Buckets

AROS ELECTRIC, INC.
Clyde Iron Works, Inc.
Connellsville Mfg. & Mine Supply Co.
Lidgerwood Industries, Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
MAYO TUNNEL & MINE EQUIPMENT CO.
NORDBERG MFG. CO.
Superior-Lidgerwood-Mundy Corp.

HOIST CONTROLS & ACCESSORIES, MINE SHAFT—also see Controls

LOGAN ENGINEERING CO.

(HOISTS, TUGGER—see Winches)

HOSE, AIR, STEAM, WATER, ET AL

Acme Rubber Mfg. Co.
Aeroquip Corp.
Aeroquip Corp. Western Div.
American Brass Co.
American Hard Rubber Co.
American Rubber Mfg. Co.
Arrowhead Products Div. Federal-Mogul-Bower, Bearings Inc.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
Boston Woven Hose & Rubber Co.
Branford Co.
Carlyle Rubber Co.
CHICAGO PNEUMATIC TOOL CO.
Cincinnati Rubber Mfg. Co. Div. Thor Power Tool Co.
Continental Rubber Works
Drilling Accessory & Mfg. Co., Inc.
Eastman-Pacific Co.
EIMCO CORP.
FLEXAUST CO.
Fyr-Fyter Co.
GATES RUBBER CO.
Gering Products, Inc.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Industrial Air Products Co.
Johnson Corp.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
New York Belting & Packing Co.
Pangborn Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Snyder & Son, Inc., M. L.
Stewart-Warner Corp. Alemite Div.
Stratoflex, Inc.
Thermoid Co. Industrial Div.
Thor Power Tool Co.
Titeflex, Inc.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Weatherhead Co. Fort Wayne Div.

HOSE FITTINGS — CLAMPS, COUPLINGS, SWIVEL JOINTS, ETC.

Aeroquip Corp.
Aeroquip Corp. Western Div.
American Rubber Mfg. Co.
Arrowhead Products Div. Federal-Mogul-Bower, Bearings Inc.
Atlas Copco Pacific, Inc.
Band-It Co.
Binks Mfg. Co.
Boston Woven Hose & Rubber Co.
Branford Co.
Carlyle Rubber Co.
Chiksan Co.
Continental Rubber Works
Crane Co.
Dixon Valve & Coupling Co.
Drilling Accessory & Mfg. Co., Inc.
Eastman Mfg. Co.
Eastman-Pacific Co.
Eaton Mfg. Co.
Fyr-Fyter Co.
GATES RUBBER CO.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
HEWITT-ROBINS, INC.
Hunt & Son, Inc., C. B.
LE-HI Div. Hose Accessories Co.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Meckum Engineering, Inc.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Snyder & Son, Inc., M. L.
Stewart-Warner Corp. Alemite Div.
Stratoflex, Inc.
Thor Power Tool Co.
U. S. Rubber Co.
Weatherhead Co. Fort Wayne Div.

HUBS, AUTO WHEEL, SELECTIVE DRIVE

Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Warn Mfg. Co.

(HYDRAULIC CYLINDERS—see Cylinders, Air & Hydraulic)

(HYDRAULIC MONITOR—see Monitors)

HYDRAULIC MOTORS

Commercial Shearing & Stamping Co. Dept. EMJ-MG
LINK-BELT CO. DEPT. EMJ-57
Oilgear Co.
Rockwell Mfg. Co.
Vickers Inc. Administrative & Engineering Center

(HYDRAULIC PUMPS—see Pumps, Hydraulic Fluid)

(HYDRAULIC RAMS—see Pumps, Hydraulic Ram)

(HYDROMETER—see Meters, Liquid Density)

I

(INSTRUMENTS—see: Drafting Equipment; Geophysical Instruments; Laboratory Equipment; Meters; Surveying Equipment)

INSULATING MATERIALS, ELECTRICAL

Anderson Mfg. Co., Albert & J. M.
Brady Co., W. H.
Continental-Diamond Fibre Corp. A Subsidiary of Budd Co.
Dow Corning Corp.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
Duquesne Mine Supply Co.
G. & W. Electric Specialty Co.
Graybar Elec. Co., Inc.
Irvington Div. Minnesota Mining & Mfg. Co.
Johns-Manville
Keasbey & Mattison Co.
National Vulcanized Fibre Co.
Phelps Dodge Copper Products Corp.
Plymouth Rubber Co.
Punch-Lok Co.
Sauereisen Cement Co.
Synthane Corp.
Taylor Fibre Co.
Thiokol Chemical Corp.
U. S. Rubber Co.
West Virginia Pulp & Paper Co.
Westinghouse Electric Corp.
Zophar Mills, Inc.

INSULATING MATERIALS, MOISTURE & GAS

Bemis Bro. Bag Co.
Johns-Manville
Zophar Mills, Inc.

INSULATING MATERIALS, SOUND

Eagle-Picher Co.
HEWITT-ROBINS, INC.
Johns-Manville
Keasbey & Mattison Co.
Laubenstein Mfg. Co.
Pacific Lumber Co.
U. S. Rubber Co.

INSULATING MATERIALS, THERMAL, CLOTH & PAPER

Carey Mfg. Co., Philip
Gatke Corp.
Johns-Manville
Keasbey & Mattison Co.
Ruberoid Co.
Union Asbestos & Rubber Co.

INSULATING MATERIALS, THERMAL, COMPOUNDS—also see Refractories

Bigelow-Liptak Corp.
Carey Mfg. Co., Philip
Dow Corning Corp.
Eagle-Picher Co.
HEWITT-ROBINS, INC.
Ironton Fire Brick Co.
Johns-Manville
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
Norton Co.
Quigley Co., Inc.
Sauereisen Cement Co.

INSULATING MATERIALS, THERMAL BOARD & SHEET—also see Refractories

Bigelow-Liptak Corp.
Carey Mfg. Co., Philip
Dow Chemical Co.
GENERAL REFRACTORIES, CO.
Johns-Manville
Keasbey & Mattison Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
Refractory & Insulation Corp.
Ruberoid Co.

INSULATING MATERIALS, THERMAL, BULK—also see Refractories

BABCOCK & WILCOX CO.
Bigelow-Liptak Corp.
Carey Mfg. Co., Philip
Eagle-Picher Co.
GENERAL REFRACTORIES, CO.
Green Fire Brick Co., A. P.
Ironton Fire Brick Co.
Johns-Manville
Keasbey & Mattison Co.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
Norton Co.
Pacific Lumber Co.
Pettinos, Inc., George F.
Quigley Co., Inc.
Refractory & Insulation Corp.

ION EXCHANGE EQUIPMENT (SPECIAL)—does not include standard auxiliary equipment; also see Water Clarification

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Water Softener Co.
Brosites Products Corp.
Cochrane Corp.
Dorr Oliver, Inc.
Enley Products, Inc.
Graver Water Conditioning Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Infilco, Inc.
Ionics, Inc.
Permutit Co.
Turbo-Mixer Div. General American Transportation Corp.
WESTERN MACHINERY CO.

ION EXCHANGE RESINS

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Chemical Process Co.
Dow Chemical Co.
Enley Products, Inc.
Graver Water Conditioning Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Permutit Co.
Rohm & Haas Co.
Van Waters & Rogers, Inc.

J

JACKS, LIFTING (SCREW, HYDRAULIC, ETC.)—also see: Hoists; Jacks, Roof

Badger Malleable & Mfg. Co.
Blackhawk Mfg. Co.
Clark Controller Co.
Duff Norton Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Illinois Iron & Bolt Co.
Ionics, Inc.
Joyce-Cridland Co.
Moran Engineering Co.
Star Jack Co.

Swett Iron Works, A. L.
Templeton, Kenly & Co.

(JACKS, PULLING—see Hoists)

JACKS, ROOF—also see Mine Supports, Re-usable Props

Duff Norton Co.
Foster Co., L. B.
Hales Co., W. M.
Joyce-Cridland Co.
Star Jack Co.
Templeton, Kenly & Co.

(JIGS—see Separators, Jig)

K

(KILNS, ROASTERS & DRYERS—see below; also see: Dryers, Furnaces; Retorts; Sintering Equipment)

KILNS, ROASTERS & DRYERS, BEE-HIVE, TUNNEL & SINGLE HEARTH (STATIONARY & MOVING)

ALLIS-CHALMERS MFG. CO. INDUSTRIES GROUP
Bigelow-Liptak Corp.
Charcoal Corp. of America
Dorr Oliver, Inc.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Kirk & Blum Mfg. Co.
STEARNS ROGER MFG. CO.

KILNS, ROASTERS & DRYERS, ROTARY

Bartlett & Snow Co., C. O.
Canadian Locomotive Co., Ltd.
CARPCO MANUFACTURING, INC.
COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO.
DIESEL ENERGY CORP.
General American Transportation Corp.
General American Transportation Corp. Louisville Dryer Div.
GOULD CO., GORDON I.
Hack Engineering Co.
HARDINGE CO., INC.
Heineken, Inc. W. P.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Machinery Center Inc.
McNally Pittsburg Mfg. Corp.
NORDBERG MFG. CO.
Ogden Iron Works
Salem-Broslus, Inc.
SMIDTH & CO., F. L.
Standard Steel Corp.
STEARNS ROGER MFG. CO.
Stroh Process Steel Co.
TRAYLOR ENGINEERING & MFG. CO.
Vulcan Iron Works
Washington Machinery Co.
Yuba Manufacturing Co.

(KILNS, ROASTERS & DRYERS, SHAFT—see Furnaces, Shaft)

KILNS, ROASTERS & DRYERS, MULTIPLE-HEARTH (MECHANICAL RABBLE) TOWER

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO.
Dorr Oliver, Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
NICHOLS ENGINEERING & RESEARCH CORP.
Pacific Foundry Co., Ltd.
STEARNS ROGER MFG. CO.

KILN (& INDUSTRIAL) GUNS (DECLOGGING)—does not include Refractory Placers

REMINGTON ARMS CO., INC.

L

LABORATORIES, ANALYZING ASSAYING & TESTING SERVICE

American Spectrographic Laboratories, Inc.
Arizona Assay Office
BOOTH CO.
California Testing Laboratories, Inc.
CARPCO MANUFACTURING, INC.
Commerical Testing & Engrg. Co.
Custom Assay Office
Deason & Nichols
DENVER EQUIPMENT CO.
Dickinson Laboratories, Inc.
El Paso Testing Laboratories
Geophysical Instrument & Supply Co.
Goodall Brothers
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Hanks, Inc., Abbot A.
Hawley & Hawley
Hill & Jude, Assayers
LEDOUX & CO.
McDowell Co., Inc.
MOBILE DRILLING & ENGINEERING INC., DIV MOBILE DRILLING INC.
Smith-Emery Co.
Snell, Inc., Foster D.
SPECTROCHEMICAL LABORATORIES, INC.
Stowell & Co., W. H.
Taller & Cooper, Inc.
Tour & Co., Sam
Tracerlab, Inc.
Ultra-Violet Products, Inc.
U. S. Testing Co., Inc.
Walker & White, Inc.
WESTERN MACHINERY CO.
Wood Assaying Co., Henry E.

LABORATORY EQUIPMENT & SUPPLIES—also see Meters

American Instrument Co., Inc.
American Paulin System
Assembly Products, Inc.
Bartlett & Snow Co., C. O.
Bico, Inc.
Blue M Electric Co.
BOOTH CO.
Cargille Laboratories, Inc. R. P.
CARPCO MANUFACTURING, INC.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Coors Porcelain Co.
Curtiss-Wright Corp. Electronics Div.
DENVER EQUIPMENT CO.
Fahrenwald Co., A. W.
Fisher & Porter Co.
Fisher Scientific Co.
GALIGHER CO.
General Chemical Div. Allied Chemical & Dye Corp. Baker & Adamson Products
Gray Instrument Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Holmes & Bros., Inc. Robert
Jarrell-Ash Co.
Knopp, Inc.
LEDOUX & CO.
Mallinckrodt Chemical Works
Mead Mill Co.
Metals Disintegrating Co. Inc. Pulverizing Machinery Div.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Minneapolis-Honeywell Regulator Co.
MORSE BROS. MACHINERY CO.
Mt. Sopris Instrument Co.
Norton Co.
Perkin Engineering Co.
Pettinos, Inc., George F.
Philips Electronics, Inc. Instruments Div.
SHARPLES CORP.
Snyder & Son, Inc., M. L.
STURTEVANT MILL CO.
Torsion Balance Co.
Turbo-Mixer Div. General American Transportation Corp.
Ultra-Violet Products, Inc.
Universal Vibrating Screen Co.
Voland & Sons, Inc.
WESTERN MACHINERY CO.

(LARRIES—see: Cars, Mine; Skips & Cages; Truck (& Tractor) Trailers & Wagons)

LIGHTING FIXTURES & LAMPS, INDUSTRIAL (ELECTRIC)—also see Flood Lights

Appleton Electric Co.
Circle F Mfg. Co.
Concordia Electric Co.
Crouse Hinds Co.
Femco, Inc.
Guyan Machy. Co.
Line Material Industries McGraw-Edison Co.
Multi Electrical Mfg. Co.
Phoenix Metal Products Co.
Pittsburgh Reflector Co.
Ray-O-Vac Co.
Steber Mfg. Co.
Sylvania Electric Products, Inc .
Westinghouse Electric Corp.

(LININGS—see below; also see: Furnace Linings; Insulating Materials)

(LININGS, ABRASION RESISTANT, METALLIC—see: Hardfacing; Metallizing; Steel, Alloy)

LININGS, ABRASION RESISTANT, NON-METALLIC—also see Coatings

Acme Rubber Mfg. Co.
Bigelow-Liptak Corp.
Carboline Co.
DENVER EQUIPMENT CO.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
GALIGHER CO.
Gates Engrg. Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Green Fire Brick Co., A. P.
Hamilton Rubber Mfg. Corp.
Haynes Stellite Co. Div. Union Carbide Corp.
Ironton Fire Brick Co.
LINATEX CORP. OF AMERICA
Mexico Refractories Co.
New York Belting & Packing Co.
Norton Co.
Patterson Foundry & Machine Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Quigley Co., Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Sauereisen Cement Co.
Thomas Foundries, Inc.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Yuba Manufacturing Co.

LININGS, CORROSION-RESISTANT, METALLIC—also see: Metallizing; Steel, Alloy; Tanks, Lined

Alco Products, Inc.
Aluminum Co. of America
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Ampco Metal, Inc.
Atlas Steels, Ltd.
Carboline Co.
CRUCIBLE STEEL CO. OF AMERICA
DENVER EQUIPMENT CO.
GALIGHER CO.
Haynes Stellite Co. Div. Union Carbide Corp.
Irwin Foundry & Mine Car Co.
Klemp Metal Grating Corp.
Reilly Tar & Chemical Corp.

LININGS, CORROSION-RESISTANT, NON-METALLIC—also see: Coatings; Tanks, Lined

Acme Rubber Mfg. Co.
American Hard Rubber Co.
Bigelow-Liptak Corp.
Carboline Co.
DENVER EQUIPMENT CO.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
Formica Corp. Subsidiary of Cyanamid
GALIGHER CO.
Garlock Packing Co.
Gates Engrg. Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co. Industrial Products
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.
LINATEX CORP. OF AMERICA
Luzerne Rubber Co.
Metal & Thermit Corp.
National Carbon Co. Union Carbide Corp.
Patterson Foundry & Machine Co.
Pennsalt Chemicals Corp.
Permagile Corp. of America
Quaker Rubber Div. H. K. Porter Company, Inc.
Quigley Co., Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Sauereisen Cement Co.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Wilbur & Williams Co.

(LOADERS—see below; also see: Conveyors; Dragline Scraper-Slushers; Excavators; Scrapers)

LOADERS, BOXCAR

Hough Co., Frank G.
Lippmann Engineering Works, Inc.
McNally Pittsburg Mfg. Corp.
Ottumwa Box Car Loader Co.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.

LOADERS, CHAIN, BELT, DRAG & BUCKET, ELEVATOR TYPES

ATHEY PRODUCTS CORP.
BARBER-GREENE CO.
Bonded Scale & Machine Co.
Butler Bin Co.
Chain Belt Co.
Christian Engineers, J. D.
Erie Strayer Co.
Gibraltar Equipment & Mfg. Co.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Irwin Foundry & Mine Car Co.
LE TOURNEAU-WESTINGHOUSE CO.
LINK-BELT CO. DEPT. EMJ-57
Pickard Industries, Inc. Central Mine Supply Co., Div.
Specialty Engineering Co.
Stephens-Adamson Mfg. Co.
Universal Dredge Mfg. Co.
Washington Machinery Co.

LOADERS, FRONT-END SCOOP, CRAWLER

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Ateco Div. Greenville Steel Car Co.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
Drott Mfg. Co.
EIMCO CORP.
Hyster Co.
International Harvester Export Co.
Link-Belt Speeder Corp.
Myers-Whaley Co., Inc.
Oliver Corp.
Thew Shovel Co.
Tractomotive Corp.

LOADERS, FRONT-END SCOOP, WHEELED

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Case Co., J. I. Industrial Div.
Clark Equipment Co. Construction Machinery Div.
GARDNER DENVER CO.
Hough Co., Frank G.
Hyster Co.
International Harvester Export Co.
Myers-Whaley Co., Inc.
Oliver Corp.
Pettibone Mulliken Corp.
SCHRAMM, INC.
Thew Shovel Co.
Tractomotive Corp.

LOADERS, GATHERING ARM

Jeffrey Mfg. Co.
JOY MFG. CO.
Long Co.

LOADERS, OVERCAST CRAWLER & RAIL

EIMCO CORP.
Marion Power Shovel Co.

LOADERS, OVERDUMP, WHEELED

Sanford-Day Iron Works, Inc.

LOADERS, SPECIAL MINE SHAFT MUCKING

BLAW KNOX CO.
Boland Development Co. Ltd.
Bucyrus-Erie Co.
EIMCO CORP.
GARDNER DENVER CO.
JOY MFG. CO.
Machinery Center Inc.
Riddell, J. Murray
Ruhr Industries
Shaft & Development Machines, Inc.
Sturrock & Co. Ltd.

LOCOMOTIVES, COMPRESSED AIR

EIMCO CORP.
Hack Engineering Co.
Machinery Center Inc.
MAYO TUNNEL & MINE EQUIPMENT CO.
Universal Dredge Mfg. Co.

LOCOMOTIVES, ELECTRIC BATTERY & TROLLEY

Atlas Car & Mfg. Co.
Easton Car & Construction Co.
Frank, M. K.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div. Loco. & Car Equip. Divs.
Ironton Engine Co.
Jeffrey Mfg. Co.
Kersey Mfg. Co., Inc.
Machinery Center Inc.
Mancha Storage Battery Locomotive Div. Goodman Mfg. Co.
Moran Engineering Co.
Universal Dredge Mfg. Co.
West Virginia Armature Co.

LOCOMOTIVES, GASOLINE, DIESEL & DIESEL-ELECTRIC

Alco Products, Inc.
Atlas Car & Mfg. Co.
BROOKVILLE LOCOMOTIVE WORKS
Canadian Locomotive Co., Ltd.
DIESEL ENERGY CORP.
Differential Steel Car Co.
Fairbanks, Morse & Co.
Frank, M. K.

General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div. Loco. & Car Equip. Divs
General Motors Corp. Electro-Motive Div.
Hack Engineering Co.
International Harvester Export Co.
Mancha Storage Battery Locomotive Div. Goodman Mfg. Co.
MAYO TUNNEL & MINE EQUIPMENT CO.
Minerals Engineering Co.
PLYMOUTH LOCOMOTIVE WORKS DIV. FATE-ROOT-HEATH CO.
Ruth Co.
Telluride Iron Works Co.
WESTINGHOUSE AIR BRAKE CO.

LOCOMOTIVES, STEAM

Frank, M. K.

(LOG WASHERS—see Scrubbers)

LUBRICANTS

Alpha Molykote Corp.
American Oil Co.
Arkansas Fuel Oil Corp.
Atlantic Refining Co.
Borne Scrymser Co.
Brooks Oil Co.
Cabot, Inc., Samuel
Cities Services Oil Co.
Climax Molybdenum Co.
Dixon Crucible Co., Joseph
Dow Corning Corp.
Esso Standard Oil Co. National & Comm. Sales Div.
Felt Products Mfg. Co.
Fiske Bros. Refining Co. Lubriplate Div.
Gulf Oil Corp.
Hales Co., W. M.
Houghton & Co., E. F.
Hulburt Oil & Grease Co.
Jesco Lubricants Co.
Jet-Lube, Inc.
Keystone Lubricating Co.
Leschen Wire Rope Div. H. K. Porter Company, Inc.
Lockray Co.
New York & New Jersey Lubricant Co.
Ohio Grease Co.
Ohio Oil Co.
Pettinos, Inc., George F.
Phillips Petroleum Co.
Pure Oil Co.
Shell Oil Co.
Sinclair Refining Co.
Socony Mobil Oil Co.
STANDARD OIL CO., OF CALIFORNIA WESTERN OPERATIONS, INC.
Standard Oil Co.—Indiana
Stewart-Warner Corp. Alemite Div.
Sun Oil Co.
Swan-Finch Oil Corp.
TEXAS CO.
Union Carbide Chemicals Co. Union Carbide Corp.
Valvoline Oil Co. Div. Ashland Oil & Refining Co.
Whitmore Mfg. Co.

LUBRICATING EQUIPMENT

Farval Corp.
Frantz Co., Inc. S. G.
Gray & Co., Inc.
Hales Co., W. M.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Lunkenheimer Co.
Manzel Div. Houdaille Industries, Inc.
Powell Co., Wm.
Stewart-Warner Corp. Alemite Div.
Thor Power Tool Co.
Trico Fuse Mfg. Co.
Wilkerson Corp.

M

MACHINE, FABRICATING & REPAIR SHOP EQUIPMENT, POWERED (LATHES, PRESSES, ETC.)—does not include Blast Cleaning Equipment; Conveyor Belting Vulcanizers; Cranes; Drill Bit & Steel Forging Hammers; Electric Cable Splicers & Vulcanizers; Forges; Furnaces; Grinders & Buffers; Hoists; Lift; Metallizing Equipment; Timber Framing Machines; Machines; Tools; Hand Power

Connellsville Mfg. & Mine Supply Co.
Industrial Air Products Co.
Kanawha Mfg. Co.
LOGAN ENGINEERING CO.
Master Mfg. Co.
Mead Mill Co.
Meckum Engineering, Inc.
Savage Co., W. J.
South Bend Lathe Works
Vulcan Iron Works
Western Gear Corp.
Wheeler Mfg. Co., C. H.

MAGNETS—also see Separators, Magnetic

AUSTIN-WESTERN WORKS CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
CARPCO MANUFACTURING, INC.
CRUCIBLE STEEL CO. OF AMERICA
Cutler-Hammer, Inc.
DINGS MAGNETIC SEPARATOR CO.
Electric Controller & Mfg. Co. Div. Square D. Co.
Homer Mfg. Co.
Magnetic Engineering & Mfg. Co.
Metallurgical Products Dept. General Electric Co.
Shrader Co., F. W.
Stackpole Carbon Co.
STEARNS MAGNETIC PRODUCTS

MAPS, GEOGRAPHIC—does not include Contractors, Mapping

Ammann Photogrammetric Engineers, Inc. Jack
Spartan Air Services

METALLIZING EQUIPMENT

Consolidated Electrodynamics Corp.
Metallizing Engineering Co., Inc.

METALLIZING SUPPLIES—also see Welding Supplies

American Chain & Cable Co., Inc. Page Steel & Wire Div.
CRUCIBLE STEEL CO. OF AMERICA
Hales Co., W. M.
Metallizing Engineering Co., Inc.
Vanadium-Alloys Steel Co.

METERS & GAGES, INDICATING & MEASURING DEVICES & INSTRUMENTS (REMOTE, RECORDING, ETC.)—see below; also see: Bin-Level Indicators; Communications; Controls; Drafting Instruments; Gas (& Moisture) Detectors; Geophysical Instruments; Laboratory Equipment; Scales; Surveying Instruments; Spectroscopic Instruments

American Instrument Co., Inc.
Auto-Lite Battery Corp.
Bailey Meter Co.
Beckman Instruments, Inc. Berkeley Div.
Bristol Co.
BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
Chatillon & Sons, John
Consolidated Electrodynamics Corp.
Curtiss-Wright Corp. Electronics Div.
Differential Steel Car Co.
El-Tronics, Inc.
Fisher & Porter Co.
Fisher Research Laboratory, Inc.
Fisher Scientific Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
General Equipment & Mfg. Co.
Gray Instrument Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Illinois Testing Laboratories, Inc.
Industrial Physics & Electronics Co.
Isotope Products, Inc. Instrument Div.
Lonergan Co., J. E.
Lufkin Rule Co.
Meriam Instrument Co.
MINE SAFETY APPLIANCES CO.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
New Jersey Meter Co.
Newage Industries, Inc.
Norden-Ketay Corp.
Nuclear Research Corp.
Penberthy Mfg. Co.
Radiation Counter Laboratories
Rawson Electrical Instrument Co.
Republic Flow Meters Co.
Rockwell Mfg. Co.
Schroeder Brothers
Sprengnether Instrument Co., Inc. W. F.
Texas Instruments, Inc. Industrial Instrumentation Div.
Uehling Instrument Co.
U. S. Gauge Div. American Machine & Metals, Inc.
Universal Atomics Div. Universal Transistor Products Corp.

METERS & GAGES, ETC., CHEMICAL (pH, POLAROGRAPH, ETC.)

Analytical Measurements, Inc.
Bailey Meter Co.
Beckman Instruments, Inc. Process Instruments Div.
Bristol Co.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Curtiss-Wright Corp. Electronics Div.
Fisher Scientific Co.
Foxboro Co.
Industrial Physics & Electronics Co.
Leeds & Northrup Co.
Macbeth Daylighting Corp.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Minneapois-Honeywell Regulator Co. Industrial Div.
Taylor & Co., W. A.
Uehling Instrument Co.

METERS & GAGES, ETC., COUNTING

Beckman Instruments, Inc. Berkeley Div.
Bristol Co.
BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
Curtiss-Wright Corp. Electronics Div.
Electro Products Laboratories
Fisher & Porter Co.
Nuclear Research Corp.
Rockwell Mfg. Co.
Uehling Instrument Co.

METERS & GAGES, ETC., ELECTRICITY (AMMETERS, VOLTMETERS, ET AL)

Assembly Products, Inc.
Auto-Lite Battery Corp.
Beckman Instruments, Inc. Berkeley Div.
Bristol Co.
Columbia Electric Mfg. Co.
Curtiss-Wright Corp. Electronics Div.
DuPont de Nemours & Co., E. I.
Esterline-Angus Co., Inc.
General Electric Co. Apparatus Sales Div.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs.
Graybar Elec. Co., Inc.
HERCULES POWDER CO.
Knopp, Inc.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Sangamo Electric Co.
Stewart-Warner Corp. Alemite Div.
Texas Instruments, Inc. Industrial Instrumentation Div.
Uehling Instrument Co.
Westinghouse Electric Corp.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.

METERS & GAGES, ETC., FLUID (FLOW, PRESSURE & VACUUM)

American Chain & Cable Co., Inc. Helicoid Gage Div.
American Paulin System
Auto-Lite Battery Corp.
Bailey Meter Co.
Beckman Instruments, Inc. Berkeley Div.
Binks Mfg. Co.
Brabender Corp.
Bristol Co.
BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
Central Scientific Co.
Consolidated Electrodynamics Corp.
Crosby Valve & Gage Co.
Fisher & Porter Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Illinois Testing Laboratories, Inc.
Industrial Physics & Electronics Co.
Isotope Products, Inc. Instrument Div.
Leupold & Stevens Instruments, Inc.
Lonegran Co., J. E.
Lunkenheimer Co.
Meriam Instrument Co.
Minneapolis Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
New Jersey Meter Co.
Norden-Ketay Corp.
Nuclear Research Corp.
Precision Thermometer & Instrument Co.
Republic Flow Meters Co.
Rockwell Mfg. Co.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Texas Instruments, Inc. Industrial Instrumentation Div.
Uehling Instrument Co.
U. S. Gauge Div. American Machine & Metals, Inc.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.

METERS & GAGES, ETC., LINEAR MEASURE (CALIPERS, MICROMETERS, ET AL)

Lufkin Rule Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Nuclear Research Corp.
Snap-on-Tools Corp.
Texas Instruments, Inc. Industrial Instrumentation Div.
Uehling Instrument Co.

METERS & GAGES, ETC., LIQUID (& SLURRY) DENSITY

Bailey Meter Co.
Beckman Instruments, Inc. Berkeley Div.
Binks Mfg. Co.
Bristol Co.
Fisher & Porter Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Industrial Physics & Electronics Co.
Isotope Products, Inc. Instrument Div.
Macbeth Daylighting Corp.
MINE & SMELTER SUPPLY CO MARCY MILL DIV.
Nuclear Research Corp.
Precision Thermometer & Instrument Co.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Texas Instruments, Inc. Industrial Instrumentation Div.
Uehling Instrument Co.

METERS & GAGES, ETC., SPEED (TACHOMETER, ET AL)

Auto-Lite Battery Corp.
Bailey Meter Co.
Beckman Instruments, Inc. Berkeley Div.
Bristol Co.
Chatillon & Sons, John
Electro Products Laboratories
Esterline-Angus Co., Inc.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Ideal Industries, Inc.
Metron Instrument Co.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Norden-Ketay Corp.
Reliance Electric & Engineering Co.
Stewart-Warner Corp. Alemite Div.
Texas Instruments, Inc. Industrial Instrumentation Div.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.

METERS & GAGES, ETC., TEMPERATURE THERMOMETERS, PYROMETERS, ETC.)

Assembly Products, Inc.
Auto-Lite Battery Corp.
Bailey Meter Co.
Blue M Electric Co.
Bristol Co.
Central Scientific Co.
Eisler Engineering Co.
Engelhard, Inc., Charles
Fisher & Porter Co.
Fisher Scientific Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Gray Instrument Co.
H-B Instrument Co., Inc.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Illinois Testing Laboratories, Inc.
Industrial Physics & Electronics Co.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Brown Instrument Div.
Minneapolis-Honeywell Regulator Co. Industrial Div.
Precision Thermometer & Instrument Co.
Republic Flow Meters Co.
Texas Instruments, Inc. Industrial Instrumentation Div.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.
Wheelco Instr. Div. Barber-Colman Co.

METERS & GAGES, ETC., TIME (CLOCKS, ETC.)

Bristol Co.
General Electric Co. Apparatus Sales Div.
Rockwell Mfg. Co.
Sangamo Electric Co.
Texas Instruments, Inc. Industrial Instrumentation Div.

(MILLS—see below; also see: Crushers; Pulverizers)

MILLS, GRINDING AUTOGENOUS

Aerofall Mills, Inc.
HARDINGE CO., INC.
Majac Inc.
Mead Mill Co.
Williams Patent Crusher & Pulverizer Co.

MILLS, GRINDING, BALL PEBBLE, ROD & TUBE

Abbé Engineering Co.
BABCOCK & WILCOX CO.
Black's Machine Shop
BOOTH CO.

Combustion Engineering Inc.
DIESEL ENERGY CORP.
DENVER EQUIPMENT CO.
DRAVO CORP.
Eastern Electro-Casting Co., Ltd.
EIMCO CORP.
Fisher Scientific Co.
Foster Wheeler Corp.
GALIGHER CO.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Machinery Center Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
MORSE BROS. MACHINERY CO.
NORDBERG MFG. CO.
Patterson Foundry & Machine Co.
SMIDTH & CO., F. L.
STEARNS ROGER MFG. CO.
Straub Mfg. Co.
TRAYLOR ENGINEERING & MFG. CO.
Vulcan Iron Works

MILLS, MOBILE UNIT (COMPLETE ORE DRESSING)—does not include Crushers, Mobile Units

CARPCO MANUFACTURING, INC.
DENVER EQUIPMENT CO.
Kenyon Walker Machinery Co.
WESTERN MACHINERY CO.

(MILLS, PUG—see Scrubbers)

MILL BALLS & SIMILAR MEDIA, GRINDING

Abbe' Engineering Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Forge Co.
BABCOCK & WILCOX CO.
Calumet Div. Calumet & Hecla, Inc.
Coates Steel Products Co.
Coeur d'Alene Hardware & Foundry Co.
Colorado Fuel & Iron Corp.
Coors Porcelain Co.
DENVER EQUIPMENT CO.
Endicott Forging & Mfg. Co.
Foster Wheeler Corp.
HARDINGE CO., INC.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Patterson Foundry & Machine Co.
Sheffield Div. Armco Steel Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Vanadium-Alloys Steel Co.

MILL LINERS, GRINDING

Abbe' Engineering Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
BALDWIN - LIMA - HAMILTON CORP. STANDARD STEEL WORKS DIV.
Calumet Div. Calumet & Hecla, Inc.
Coors Porcelain Co.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
EIMCO CORP.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
Kensington Steel Co.
LINATEX CORP. OF AMERICA
NATIONAL MALLEABLE & STEEL CASTINGS CO.
NORDBERG MFG. CO.
Patterson Foundry & Machine Co.
Sorel Steel Foundries, Ltd.
STEARNS ROGER MFG. CO.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Thomas Foundries, Inc.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

MILL RODS, GRINDING

Abbe' Engineering Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Forge Co.
Bethlehem Pacific Coast Steel Corp.
Colorado Fuel & Iron Corp.
DENVER EQUIPMENT CO.
HARDINGE CO., INC.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Sheffield Div. Armco Steel Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

MILL SHELLS, GRINDING

Abbe' Engineering Co.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
BALDWIN - LIMA - HAMILTON CORP. STANDARD STEEL WORKS DIV.
DENVER EQUIPMENT CO.
HARDINGE CO., INC.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
NORDBERG MFG. CO.
STEARNS ROGER MFG. CO.

(MINE CARS—see Cars, Mine)

MINE DOORS, AUTOMATIC

AMERICAN MINE DOOR CO.
Coeur d'Alene Hardware & Foundry Co.

(MINE SUPPORTS—see below; also see: Rock Bolts; Fencing, Metal Wire)

MINE SUPPORTS, METAL, ARCH PLATES & SETS

Bethlehem Steel Co., Inc.
Commercial Shearing & Stamping Co. Dept. EMJ-MG
Irwin Foundry & Mine Car Co.
Sutton Steele & Steele, Inc.

MINE SUPPORTS, METAL, ARCH, YIELDABLE

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Irwin Foundry & Mine Car Co.

MINE SUPPORTS, METAL, RE-USABLE & MOVABLE PROP—also see Jacks, Roof

Douety Mining Equipment Ltd.
Duff Norton Co.
Herold Manufacturing Co.
Irwin Foundry & Mine Car Co.
Templeton, Kenly & Co.

MINERAL DEALERS & SALES AGENTS

AMERICAN METAL CO.
ASSOCIATED METALS & MINERALS CORP.
AMERICAN SMELTING & REFINING CO.
Baker & Co., Inc.
CALABRIAN CO., INC.
Continental Mineral Processing Co.
Continental Ore Corp.
DeSousa Co., Inc., J. E.
GODOY & CO., INC., E. A.
Grace & Co., W. R.
Haesler Metal & Ore Corp.
Handy & Harman
INTERNATIONAL BARTERING CO.
INTERNATIONAL MINERALS & METALS CORP.
Metal Traders Inc.
Minerals Engineering Co.
New Jersey Zinc Co.
Overseas Raw Materials Corp.
Philipp Bros., Inc.
Pitkin, Inc.
TENNANT SONS & CO., C. OF N. Y.
Ultra-Violet Products, Inc.
U. S. Smelting, Refining & Mining Co. Inc.
Vale Do Rio Doce Trading Co., Inc.
WAH CHANG CORP.

(MIXERS—see Agitators)

MONITOR, HYDRAULIC (WATER)

Chiksan Co.
Yuba Manufacturing Co.

(MOTORS—see: Air Motors; Electric Motors; Hydraulic Motors)

(MUCKING MACHINES—see Loaders)

N

NODULIZING, PELLETIZING & BRIQUETTING EQUIPMENT—does not include Sintering Equipment

DRAVO CORP.
Dwight-Lloyd Div. McDowell Co., Inc.
GOULD CO., GORDON I.
HARDINGE CO., INC.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
McDowell Co., Inc.
Wellman Engineering Co. McDowell Enterprise

NOZZLES—does not include Monitors, Hydraulic

Bete Fog Nozzle, Inc.
Binks Mfg. Co.
BOOTH CO.
Branford Co.
Chain Belt Co.
Deister Concentrator Co.
Deister Machine Co.
Elkhart Brass Mfg. Co., Inc.
Johnson-March Corp.
LINK-BELT CO. DEPT. EMJ-57
Norton Co.
Pangborn Corp.
Penberthy Mfg. Co.
Pettinos, Inc., George F.
SPRAYING SYSTEMS CO.
U. S. Rubber Co.
Yarnall-Waring Co.
Yuba Manufacturing Co.

O

OFFICE MACHINES & EQUIPMENT

Automatic Electric Co.
Bruning Co., Inc. Charles
Ozalid Div. General Aniline & Film Corp.
Peerless Photo Products, Inc.
Remington Rand Div. Sperry Rand Corp.
Republic Steel Corp.
Taller & Cooper, Inc.

(ORE, DEALERS—See Mineral Dealers and Sales Agents)

P

PACKING
Acme Rubber Mfg. Co.
Belmont Packing & Rubber Co.
Boston Woven Hose & Rubber Co.
Chemical & Power Products, Inc.
Duriron Co., Inc.
Felt Products Mfg. Co.
Garlock Packing Co.
Gatke Corp.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Graton & Knight Co., Inc.
Greene, Tweed & Co.
Hamilton Rubber Mfg. Corp.
HEWITT-ROBINS, INC.
Houghton & Co., E. F.
Johns-Manville
Keasbey & Mattison Co.
New York Belting & Packing Co.
Quaker Rubber Div. H. K. Porter Company, Inc.
Raybestos-Manhattan, Inc. Manhattan Rubber Div.
Republic Rubber Div. Lee Rubber & Tire Corp.
Rhoads & Son, J. E.
Snyder & Son, Inc., M. L.
Union Asbestos & Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
WESTINGHOUSE AIR BRAKE CO. IND. PRODUCTS DIV.

PAINTS—also see Coatings

Aluminum Co. of America
Cabot, Inc., Samuel
Canadian Industries Ltd.
Carboline Co.
Carbolineum Wood Preserving Co.
Carey Mfg. Co., Philip
Dixon Crucible Co., Joseph
DuPont de Nemours & Co., E. I.
Koppers Co. Inc.
Master Bronze Powder Co., Inc.
Metal & Thermit Corp.
National Lead Co.
Pennsalt Chemicals Corp.
Quigley Co., Inc.
Rust-Oleum Corp.
Sherwin-Williams Co.
Wilbur & Williams Co.

PETROLEUM PRODUCTS—also see Lubricants

Borne Scrymser Co.
Brooks Oil Co.
Cities Service Oil Co.
Gulf Oil Corp.
Houghton & Co., E. F.
Jet-Lube, Inc.
New York & New Jersey Lubricant Co.
Phillips Petroleum Co.
Pure Oil Co.
Shell Oil Co.
Sinclair Refining Co.
STANDARD OIL CO., OF CALIFORNIA WESTERN OPERATIONS, INC.
Standard Oil Co.—Indiana
Sun Oil Co.
Swan-Finch Oil Corp.
Valvoline Oil Co. Div. Ashland Oil Co. Div.

(pH INDICATORS—see Meters, Chemical)

(PIPE & TUBING—see below; also see Electrical Conduit)

PIPE, IRON & STEEL

Alco Products, Inc.
Armco Drainage & Metal Products, Inc.
Atlas Steels, Ltd.
Beall Pipe & Tank Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
BLAW-KNOX CO. POWER PIPING & SPRINKLER DIV.
Byers Co., A. M.
Carpenter Steel Co.
CRUCIBLE STEEL CO. OF AMERICA
Dominion Steel & Coal Corp., Ltd.
Electric Steel Foundry Co.
Foster Co., L. B.
Goyne Pump Co.
Graybar Elec. Co., Inc.
JONES & LAUGHLIN STEEL CORP.
Kellogg Co., M. W.
NATIONAL SUPPLY CO.
NAYLOR PIPE CO.
Ogden Iron Works
PITTSBURGH STEEL CO.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Swepco Tube Corp.
U. S. Pipe & Foundry Co.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
U. S. STEEL CORP. NATIONAL TUBE DIV.
Wheeling Steel Corp.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

PIPE, NON-FERROUS METAL

Aluminum Co. of America
American Brass Co
AMERICAN SMELTING & REFINING CO FEDERATED METALS DIV.
Ampco Metal, Inc.
Foster Co., L. B.
Goyne Pump Co.
Graybar Elec. Co., Inc.
Haynes Stellite Co. Div Union Carbide Corp.
International Nickel Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mueller Brass Co.
National Lead Co.
Phelps Dodge Copper Products Corp.
Revere Copper & Brass, Inc.
Reynolds Metals Co.
Swepco Tube Corp.
Triangle Conduit & Cable Co., Inc.

PIPE (METAL), NON-METALLIC LINED

American Hard Rubber Co.
GALIGHER CO.
Graybar Elec. Co., Inc.
LINATEX CORP. OF AMERICA
U. S. Pipe & Foundry Co.

PIPE, PLASTIC

American Hard Rubber Co.
Anchor Plastics Co. Inc.
Carlon Products Corp.
Crane Co.
Electric Steel Foundry Co.
Formica Corp. Subsidiary of Cyanamid
Foster Co., L. B.
Franklin Plastics Co.
Gering Products, Inc.
Goodall Rubber Co.
Goodrich Industrial Products Co. B. F.
Goodyear Tire & Rubber Co
Graybar Elec. Co., Inc.
Irvington Div. Minnesota Mining & Mfg. Co.
Johnson Plastic Corp.
Luzerne Rubber Co.
Minnesota Mining & Mfg. Co.
Mueller Brass Co.
Plastex Co.
Quaker Rubber Div. H. K. Porter Company, Inc.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Synthane Corp.
Triangle Conduit & Cable Co., Inc.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV
U. S. STEEL CORP. NATIONAL TUBE DIV.
Youngstown Sheet & Tube Co.

PIPE, VENTILATION—does not include Ventilation Tubing, Non-Metallic

Armco Drainage & Metal Products, Inc.
Kirk & Blum Mfg. Co
NAYLOR PIPE CO.
Swepco Tube Corp.
Triangle Conduit & Cable Co., Inc.

PIPE, WOOD

Acme Tank Mfg. Co.
Arrow Tank Co.
Atlantic Tank Corp.
Caldwell Co., W. E.
Hauser-Stender Tank Co.
Michigan Pipe Co.

National Tank & Pipe Co.
Pacific Wood Tank Corp.
Santa Fe Tank Div. Fluor Products Co.
Sutphen, Peter O.
Windeler Co., Ltd., George

PIPE FITTINGS—also see: Pipe Line Traps; Nozzles; Valves

Alco Products, Inc.
Aluminum Co. of America
American Hard Rubber Co.
Ampco Metal, Inc.
Appleton Electric Co.
Band-It Co.
BLAW-KNOX CO. POWER PIPING & SPRINKLER DIV.
Chase Brass & Copper Co.
Crane Co.
CRUCIBLE STEEL CO. OF AMERICA
Dresser Mfg. Div. Dresser Industries, Inc.
Duriron Co., Inc.
Electric Steel Foundry Co.
Fairbanks Co.
Foster Co., L. B.
Franklin Plastics Co.
Goodrich Industrial Products Co., B. F.
Goyne Pump Co.
GRINNELL CO., INC.
Gustin-Bacon Mfg. Co.
Haynes Stellite Co. Div. Union Carbide Corp.
International Nickel Co.
Jefferson Union Co.
Johnson Plastic Corp.
Ladish Co.
Luzerne Rubber Co.
Meckum Engineering, Inc.
Mueller Brass Co.
NAYLOR PIPE CO.
Plastex Co.
Stockham Valves & Fittings
Swepco Tube Corp.
Triangle Conduit & Cable Co., Inc.
Tube Turns Div. National Cylinder Gas Co.
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
VICTAULIC CO. OF AMERICA
Walworth Co.
Weatherhead Co. Fort Wayne Div.
Zurn Mfg., J. A. Div. Zurn Industries, Inc.

PIPELINE TRAPS, AIR, STREAM & WATER

Crane Co.
New Jersey Meter Co.
Yarnall-Waring Co.

(PNEUMATIC. . .—see Air. . .)

(POWER PLANTS—see Electric Generating Power Plants)

(POWER SHOVELS—see Excavators)

POWER TAKE-OFFS—also see Drives

Davey Compressor Co.
Drilling Accessory & Mfg. Co., Inc.
Failing Co., George E.
Gar Wood Industries, Inc.
Hayes Steel Products, Ltd.
Mayhew Machine & Supply Co.
Minerals Engineering Co.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Stimmel Winch Co., Inc.
TWIN DISC CLUTCH CO.
Western Gear Corp.

(PROTECTIVE CLOTHING—see Safety Clothing)

(PUG MILLS—see Scrubbers)

(PULLEYS—see Blocks)

(PULLEYS, MAGNETIC—see Separators, Magnetic)

PULVERIZERS—also see: Crushers; Mills, Grinding

Acme Road Machinery Co., Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
BABCOCK & WILCOX CO.
Bartlett & Snow Co., C. O.
Bico, Inc.
Bradley Pulverizer Co.
Buffalo Hammer Mill Corp.
Combustion Engineering Inc.
Combustion Engineering, Inc. Raymond Div.
DENVER EQUIPMENT CO.
Denver Fire Clay Co.
DIESEL ENERGY CORP.
Foster Wheeler Corp.
Gruendler Crusher & Pulverizer Co.
HARDINGE CO., INC.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Lippmann Engineering Works, Inc.
Machinery Center Inc.
Majac Inc.
Mead Mill Co.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
MORSE BROS. MACHINERY CO.
Norma-Hoffman Bearings Corp.
Pulva Corp.
SMIDTH & CO., F. L.
STURTEVANT MILL CO.
Whiting Corp.
Williams Patent Crusher & Pulverizer Co.

PUMPS, AIR DRIVEN

Aldrich Pump Co.
American-Marsh Pumps, Inc.
Atlas Copco Pacific, Inc.
Binks Mfg. Co.
CHICAGO PNEUMATIC TOOL CO.
Davidson Co., M. T.
Dorr Oliver, Inc.
Gray & Co., Inc.
Hayes Steel Products, Ltd.
Hills-McCanna Co.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
LONGYEAR CO., E. J.
SCRAMM, INC.
Warren Steam Pump Co.
Worthington Corp.

PUMPS, AIR LIFT

CHICAGO PNEUMATIC TOOL CO.
Condenser Service & Engineering Co.
INGERSOLL-RAND CO.
Nash Engineering Co.
Worthington Corp.

PUMPS, CENTRIFUGAL & TURBINE

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Crucible Products Co.
American-Marsh Pumps, Inc.
American Well Works
Ampco Metal, Inc.
Barrett Haentjens & Co.
Buffalo Forge Co.
Byron Jackson Div. Borg-Warner Corp.
Carver Pump Co.
Chain Belt Co.
Davidson Co., M. T.
Dean Hill Pump Co.
DeLaval Steam Turbine Co.
Deming Co.
Dorr Oliver, Inc.
Duriron Co., Inc.
Fairbanks, Morse & Co.
Flood City Brass & Elec. Co.
Food Machinery & Chemical Corp. Peerless Pump Div.
GARDNER DENVER CO.
Gorman-Rupp Co.
Goulds Pumps, Inc.
Goyne Pump Co.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Jaeger Machine Co.
Johnston Pump Co.
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
Layne & Bowler Pump Co. of Los Angeles
Lecourtenay Co.
McDonald Mfg. Co., A. Y.
McNally Pittsburg Mfg. Corp.
Morris Machine Works
MORSE BROS. MACHINERY CO.
National Carbon Co. Union Carbide Corp.
New York Air Brake Co. Aurora Pump Div.
Novo Pump & Engine Co.
Pennsylvania Drilling Co.
Pennsylvania Pump & Compressor Co.
Rice Pump & Machine Co.
Standard Elec. Mfg. Co., Inc.
Swaby Mfg. Co.
Warren Steam Pump Co.
Weinman Pump Mfg. Co.
Wheeler Mfg. Co., C. H.
WILFLEY & SONS, A. R.
Worthington Corp.

(PUMPS, CONCRETE & REFRACTORY—see: Concrete; Refractories)

PUMPS, CORROSIVE LIQUIDS

Aldrich Pump Co.
ALLEN-SHERMAN-HOFF PUMP CO.
American Hard Rubber Co.
American-Marsh Pumps, Inc.
Ampco Metal, Inc.
Barrett Haentjens & Co.
Binks Mfg. Co.
Brosites Products Corp.
Buffalo Forge Co.
Byron Jackson Div. Borg-Warner Corp.
Canadian Locomotive Co., Ltd.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
Duriron Co., Inc.
Food Machinery & Chemical Corp. Peerless Pump Div.
GALIGHER CO.
GARDNER DENVER CO.
Goulds Pumps, Inc.
Goyne Pump Co.
Hills-McCanna Co.
Hypro Engineering, Inc.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Johnston Pump Co.
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
Lecourtenay Co.
LINATEX CORP. OF AMERICA
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Luzerne Rubber Co.
NAGLE PUMPS, INC.
National Carbon Co. Union Carbide Corp.
New York Air Brake Co. Aurora Pump Div.
Penberthy Mfg. Co.
Pennsylvania Pump & Compressor Co.
Shriver & Co., T.
Warren Steam Pump Co.
Weinman Pump Mfg. Co.
WESTERN MACHINERY CO.
Wintroath Pumps Div. Worthington Corp.
WILFLEY & SONS, A. R.
Worthington Corp.

PUMPS, DEEP WELL—also see Pumps, Submersible

American Well Works
Barnes Mfg. Co.
Byron Jackson Div. Borg-Warner Corp.
Deming Co.
Fairbanks, Morse & Co.
Food Machinery & Chemical Corp. Peerless Pump Div.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Johnston Pump Co.
Layne & Bowler Pump Co. of Los Angeles
McDonald Mfg. Co., A. Y.
New York Air Brake Co. Aurora Pump Div.
Pennsylvania Drilling Co.
Robbins & Myers, Inc.
Weinman Pump Mfg. Co.
Wintroath Pumps Div. Worthington Corp.
Worthington Corp.

PUMPS, DIAPHRAGM

Barnes Mfg. Co.
Brosites Products Corp.
Carver Pump Co.
Chain Belt Co.
Construction Machy. Co.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
Essick Manufacturing Co.
Gorman-Rupp Co.
Hypro Engineering, Inc.
Jaeger Machine Co.
Marlow Pumps Div. Bell & Gossett Co.
McGowan Pump Div. Leyman Mfg. Corp.
MORSE BROS. MACHINERY CO.
Novo Pump & Engine Co.
Philadelphia Belting Co.
Rice Pump & Machine Co.
Shriver & Co., T.
WESTERN MACHINERY CO.
Worthington Corp.

PUMPS, DREDGE & GRAVEL—also see Pumps, Sand & Slime

ALLEN-SHERMAN-HOFF PUMP CO.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Brake Shoe Co.
American Hoist & Derrick Co.
Carver Pump Co.
Ellicott Machine Corp.
Erie Pump & Engine Works
Essick Manufacturing Co.
Georgia Iron Works Co.
INGERSOLL-RAND CO.
Kansas City Hay Press
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
Meckum Engineering, Inc.
Morris Machine Works
NAGLE PUMPS, INC.
Pettibone Mulliken Corp.
Sutton Steele & Steele, Inc.
Thomas Foundries, Inc.
WILFLEY & SONS, A. R.
Worthington Corp.

PUMPS, HYDRAULIC FLUID

Aldrich Pump Co.
American Instrument Co., Inc.
Anthony Co.
Binks Mfg. Co.
Commercial Shearing & Stamping Co. Dept. EMJ-MG
Davidson Co., M. T.
DeLaval Steam Turbine Co.
Hales Co., W. M.
INGERSOLL-RAND CO.
Johnston Pump Co.
Kobe, Inc.
Krogh Pump & Equipment Co., Inc.
Ledeen, Inc.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
New York Air Brake Co. Aurora Pump Div.
Oilgear Co.
Owatonna Tool Co.
Penberthy Mfg. Co.
Pennsylvania Pump & Compressor Co.
Star Jack Co.
Vickers Inc.
Worthington Corp.
Weinman Pump Mfg. Co.

PUMPS, HYDRAULIC RAM-TYPE

Blackhawk Mfg. Co.
Ledeen, Inc.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Moran Engineering Co.
Templeton, Kenly & Co.

PUMPS, PISTON & PLUNGER

Aldrich Pump Co.
American-Marsh Pumps, Inc.
Davidson Co., M. T.
Deming Co.
Dorr Oliver, Inc.
Eastman-Pacific Co.
Flood City Brass & Elec. Co.
GARDNER DENVER CO.
Hills-McCanna Co.
Kobe, Inc.
Ledeen, Inc.
Lincoln Engineering Co. Div. McNeil Machine & Engineering Co.
Marlow Pumps Div. Bell & Gossett Co.
McDonald Mfg. Co., A. Y.
NATIONAL SUPPLY CO.
Novo Pump & Engine Co.
Oilgear Co.
Oliver Corp. A. B. Farquhar Div.
Pennsylvania Drilling Co.
Sanford-Day Iron Works, Inc.
Vickers Inc.
Warren Steam Pump Co.
Worthington Corp.

PUMPS, PRIMING

Barrett Haentjens & Co.
Binks Mfg. Co.
Duriron Co., Inc.
Goulds Pumps, Inc.
INGERSOLL-RAND CO.
Marlow Pumps Div. Bell & Gossett Co.
McGowan Pump Div. Leyman Mfg. Corp.
Nash Engineering Co.
New York Air Brake Co. Aurora Pump Div.
Penberthy Mfg. Co.
Worthington Corp.

(PUMPS, RECIPROCATING—see Pumps, Piston)

PUMPS, ROTARY DISPLACEMENT

CHICAGO PNEUMATIC TOOL CO.
DeLaval Steam Turbine Co.
Deming Co.
Fairbanks, Morse & Co.
Goulds Pumps, Inc.
Hypro Engineering, Inc.
Nash Engineering Co.
Oilgear Co.
Porto Pump Inc.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Vickers Inc.
Warren Steam Pump Co.
Worthington Corp.

PUMPS, SAND & SLIME

ALLEN-SHERMAN-HOFF PUMP CO.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Brake Shoe Co.
Barrett Haentjens & Co.
CARPCO MANUFACTURING INC.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
Ellicott Machine Corp.
Erie Pump & Engine Works
GALIGHER CO.
Georgia Iron Works Co.
Goyne Pump Co.
INGERSOLLL-RAND CO.
Jaeger Machine Co.

Kansas City Hay Press
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
LINATEX CORP. OF AMERICA
Machinery Center Inc.
McGowan Pump Div. Leyman Mfg. Corp.
Morris Machine Works
NAGLE PUMPS, INC.
Robbins & Myers, Inc.
Spang & Co.
Telluride Iron Works Co.
Thomas Foundries, Inc.
Weinman Pump Mfg. Co.
WESTERN MACHINERY CO.
WILFLEY & SONS, A. R.
Worthington Corp.
Yuba Manufacturing Co.

PUMPS, SUBMERSIBLE

ALLEN-SHERMAN-HOFF PUMP CO.
American Crucible Products Co.
Barnes Mfg. Co.
Byron Jackson Div. Borg-Warner Corp.
Carver Pump Co.
CHICAGO PNEUMATIC TOOL CO.
Deming Co.
Fairbanks, Morse & Co.
Food Machinery & Chemical Corp. Peerless Pump Div.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Johnston Pump Co.
Layne & Bowler Pump Co. of Los Angeles
McDonald Mfg. Co., A. Y.
New York Air Brake Co. Aurora Pump Div.
Penberthy Mfg. Co.
Pennsylvania Drilling Co.
SCHRAMM, INC.
Swaby Mfg. Co.
Wintroath Pumps Div. Worthington Corp.
Worthington Corp.

PUMPS, SUMP

ALLEN-SHERMAN-HOFF PUMP CO.
American Crucible Products Co.
American-Marsh Pumps, Inc.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Buffalo Forge Co.
Byron Jackson Div. Borg-Warner Corp.
Canadian Locomotive Co., Ltd.
Carver Pump Co.
CHICAGO PNEUMATIC TOOL CO.
Davidson Co., M. T.
Deming Co.
DENVER EQUIPMENT CO.
Essick Manufacturing Co.
Fairbanks, Morse & Co.
Food Machinery & Chemical Corp. Peerless Pump Div.
GALIGHER CO.
GARDNER DENVER CO.
Gorman Rupp Co.
Goulds Pumps, Inc.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
Jacuzzi Bros., Inc.
Jaeger Machine Co.
Johnston Pump Co.
Krogh Pump & Equipment Co., Inc.
Lawrence Pumps, Inc.
Layne & Bowler Pump Co. of Los Angeles
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
NAGLE PUMPS, INC.
McDonald Mfg. Co., A. Y.
New York Air Brake Co. Aurora Pump Div.
Penberthy Mfg. Co.
Reed Roller Bit Co.
Rice Pump & Machine Co.
Robbins & Myers, Inc.
SCHRAMM, INC.
Standard Elec. Mfg. Co., Inc.
Swaby Mfg. Co.
Telluride Iron Works Co.
Thor Power Tool Co.
Warren Steam Pump Co.
Weinman Pump Mfg. Co.
WESTERN MACHINERY CO.
WESTINGHOUSE AIR BRAKE CO.
Wheeler Mfg. Co., C. H.
Wintroath Pumps Div. Worthington Corp.
Worthington Corp.

PUMPS, VACUUM

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American-Marsh Pumps, Inc.
Barrett Haentjens & Co.
Beach-Russ Co.
Bruning Co., Inc. Charles
Central Scientific Co.
CHICAGO PNEUMATIC TOOL CO.
Consolidated Electrodynamics Corp.
Davidson Co., M. T.
Eisler Engineering Co.
GARDNER DENVER CO.
General American Transportation Corp.
Goyne Pump Co.
INGERSOLL-RAND CO.
Jaeger Machine Co.
Machinery Center Inc.
Nash Engineering Co.
Penberthy Mfg. Co.
Pennsylvania Pump & Compressor Co.
Precision Thermometer & Instrument Co.
Roots-Connersville Blower Div. Dresser Industries, Inc.
Warren Steam Pump Co.
Worthington Corp.

PUMP ACCESSORIES

Barrett Haentjens & Co.
Cutler-Hammer, Inc.
Gatke Corp.
Jacuzzi Bros., Inc.
U. S. Rubber Co.

(PYROMETERS—see Meters, Temperature)

R

RADIATION DETECTORS

Automatic Switch Co.
Beckman Instruments, Inc. Berkeley Div.
CARPCO MANUFACTURING, INC.
Curtiss-Wright Corp. Electronics Div.
Detectron Corp.
Engineers Syndicate, Ltd.
Fisher Research Laboratory, Inc.
General Electric Co. Apparatus Sales Div.
Geophysical Instrument & Supply Co.
Menlo Research Laboratory
Mt. Sopris Instrument Co.
Nuclear-Chicago Corp.
Nuclear Research Corp.
Philips Electronics, Inc. Instruments Div.
Precision Radiation Instruments, Inc.
Radiation Counter Laboratories
Special Instruments Laboratory, Inc.
Tracerlab, Inc.
Ultra-Violet Products, Inc.
Universal Atomics Div. Universal Transistor Products Corp.
Victoreen Instrument Co.
Western Radiation Laboratory
Whites Electronics

(RADIO—see Communications)

RAIL & TRACK

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Brake Shoe Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Colorado Fuel & Iron Corp.
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Machinery Center Inc.
Ryerson & Son, Inc., Joseph T.
Sweet's Steel Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

RAIL & TRACK ACCESSORIES—also see specific item under Car . . . Rail . . . or Track

American Brake Shoe Co.
American Mine Door Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Colorado Fuel & Iron Corp.
Conley Frog & Switch Co.
Dominion Steel & Coal Corp., Ltd.
Duquesne Mine Supply Co.
Farrell-Cheek Steel Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Miners' Hardware Supply Co.
Nolan Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Utility Mine Equipment Co.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)
Whiting Corp.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

RAIL BENDERS

ALDON CO.
CARD IRON WORKS, C. S.
Duquesne Mine Supply Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Utility Mine Equipment Co.

RAIL BONDS

AMERICAN MINE DOOR CO.
American Steel & Wire Div. U. S. Steel Corp.
Ensign Electric & Mfg. Co.
Frank, M. K.
Hales Co., W. M.
Ohio Brass Co.
Penn Machine Co.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

RAIL BRACES

American Brake Shoe Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Conley Frog & Switch Co.
Coover Railroad Track Brace Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Nolan Co.
Pettibone Mulliken Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)

RAIL CLAMPS, FISHPLATES, TIE-PLATES & FROGS

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Brake Shoe Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Conley Frog & Switch Co.
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Frank, M. K.
Frog, Switch & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Pettibone Mulliken Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

RAIL DRILLS & PUNCHES

Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
NORDBERG MFG. CO.
Ohio Brass Co.

RAIL SIGNALS—also see Communications

AMERICAN MINE DOOR CO.
Bethlehem Pacific Coast Steel Corp.
Frank, M. K.
General Equipment & Mfg. Co.
Miners' Hardware Supply Co.
NACHOD & U. S. SIGNAL CO.
NATIONAL FILTER MEDIA CORP.
Taller & Cooper, Inc.
WESTINGHOUSE AIR BRAKE CO.

RAIL SPIKES

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Colorado Fuel & Iron Corp.
Dominion Steel & Coal Corp., Ltd.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Sheffield Div. Armco Steel Corp.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

RAIL SWITCHES & CROSSINGS

American Brake Shoe Co.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
Conley Frog & Switch Co.
Foster Co., L. B.
Frank, M. K.
Frog, Switch & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)

RAIL SWITCH THROWERS

AMERICAN MINE DOOR CO.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
CARD IRON WORKS, C. S.
CHEATHAM ELECTRIC SWITCHING DEVICE CO.
Conley Frog & Switch Co.
Foster Co., L. B.
Frank, M. K.
General Equipment & Mfg. Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)

RAIL TIES, STEEL

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Foster Co., L. B.
Frank, M. K.
Sweet's Steel Co.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)

(REAGENTS—see: Chemicals; Flotation Reagents; Water Clarification Chemicals)

(REAGENT FEEDERS—see Feeders)

(REFRACTORIES—see below; also see Insulation)

REFRACTORIES, BRICK

BABCOCK & WILCOX CO.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Abrasives Corp.
GENERAL REFRACTORIES, CO.
Green Fire Brick Co., A. P.
HARBISON-WALKER REFRACTORIES CO.
Ironton Fire Brick Co.
Johns-Manville
Kaiser Aluminum & Chemical Sales, Inc.
Laclede-Christy Div. H. K. Porter Company, Inc.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
National Lead Co.
North American Refractories Co.
Norton Co.
Quigley Co., Inc.
Robinson Clay Product Co.
Samuel & Co., Inc., Frank

REFRACTORIES, CASTABLE

BABCOX & WILCOX CO.
Denver Fire Clay Co.
Electro Refractories & Abrasives Corp.
GENERAL REFRACTORIES, CO.
Green Fire Brick Co., A. P.
HARBISON-WALKER REFRACTORIES CO.
Ironton Fire Brick Co.
Johns-Manville
Laclede-Christy Div. H. K. Porter Company, Inc.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
North American Refractories Co.
Norton Co.
Pettinos, Inc., George F.
Quigley Co., Inc.
Refractory & Insulation Corp.
Robinson Clay Product Co.
Sauereisen Cement Co.
Samuel & Co., Inc., Frank

REFRACTORY CEMENT

BABCOCK & WILCOX CO.
Corhart Refractories Co.
Denver Fire Clay Co.
Dixon Crucible Co., Joseph
Eagle-Picher Co.
Electro Refractories & Abrasives Corp.
GENERAL REFRACTORIES, CO.
Green Fire Brick Co., A. P.
HARBISON-WALKER REFRACTORIES CO.
Ironton Fire Brick Co.
Johns-Manville
Laclede-Christy Div. H. K. Porter Company, Inc.
Mexico Refractories Co.
Mullite Works Refractories Div. H. K. Porter Company, Inc.
National Carbon Co. Div. Union Carbide Corp.
North American Refractories Co.
Norton Co.
Pettinos, Inc., George F.
Quigley Co., Inc.
Refractory & Insulation Corp.

Robinson Clay Product Co.
Samuel & Co., Inc., Frank
Sauereisen Cement Co.

REFRACTORY MATERIAL OTHER THAN ABOVE

Aluminum Co. of America
BABCOCK & WILCOX CO.
Denver Fire Clay Co.
GENERAL REFRACTORIES, CO.
Green Fire Brick Co., A. P.
HARBISON-WALKER REFRACTORIES CO.
Ironton Fire Brick Co.
Kiemp Metal Grating Corp.
Laclede-Christy Div. H. K. Porter Co., Inc.
Mexico Refractories Co.
Monsanto Chemical Co.
Mullite Works, Refractories Div. H. K. Porter Co., Inc.
National Carbon Co. Div. Union Carbide Corp.
Norton Co.
Quigley Co., Inc.
Reintjes Co., George P.

REFRACTORY PLACERS, SPRAYERS, PUMPS & BLOWERS

Cement Gun Co.
Mexico Refractories Co.
Quigley Co., Inc.

(RESPIRATORS—see Safety Respirators)

RETORTS & DISTILLATION PROCESS EQUIPMENT, LIQUID—does not include: Boilers; Laboratory Equipment

Standard Steel Corp.

RETORTS & DISTILLATION PROCESS EQUIPMENT, SOLID—also see: Furnaces; Kilns; does not include Laboratory Equipment

GOULD CO., GORDON I.
Hevi-Duty Electric Co.
Standard Steel Corp.

ROCK (& ROOF) BOLTS

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Colorado Fuel & Iron Corp.
Commercial Shearing & Stamping Co. Dept. EMJ-MG
Hales Co., W. M.
Hayes Steel Products, Ltd.
Lamson & Sessions Co.
Ohio Brass Co.
Pattin Manufacturing Co.
Pittsburgh Screw & Bolt Co.
Republic Steel Corp.
Sika Chemical Corp.
West Virginia Works Connors Steel Div. H. K. Porter Co., Inc. (Delaware)
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

ROCK (& ROOF) BOLT ACCESSORIES

Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Central Mine Equipment Co.
Colorado Fuel & Iron Corp.
Goodyear Tire & Rubber Co. Industrial Products
Hayes Steel Products, Ltd.
Ohio Brass Co.
Pattin Manufacturing Co.
Pittsburgh Screw & Bolt Co.
Sika Chemical Corp.
West Virginia Works Connors Steel Div. H. K. Porter Company, Inc. (Delaware)
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

ROOF BOLTING MACHINES

Acme Machinery Co.
Atlas Copco Pacific, Inc.
CHICAGO PNEUMATIC TOOL CO.
Fletcher & Co., J. H.
Hayes Steel Products, Ltd.
Holman Bros.—Canada Ltd.
JOY MFG. CO.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO.
Thor Power Tool Co.

ROOFING & SIDING, METAL

Aluminum Co. of America
American Brass Co.
Arrowhead Steel Buildings, Inc.
Bethlehem Steel Co., Inc.
Butler Manufacturing Co.
CRUCIBLE STEEL CO. OF AMERICA
Inland Steel Products Co.
International Nickel Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mahon Co., R. C.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.

ROOFING & SIDING, NON-METALLIC

Carey Mfg. Co., Philip
Koppers Co. Inc.
Johns-Manville
Keasbey & Mattison Co.
Ruberoid Co.
STANDARD OIL CO., OF CALIFORNIA WESTERN OPERATIONS, INC.

(RUST PREVENTIVES—see Coatings)

S

(SAFETY EQUIPMENT—see below; also see: Fire Fighting; First Aid)

SAFETY CLOTHING, HATS, BELTS & SHOES

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
American Optical Co.
Bullard Co., E. D.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Graton & Knight Co., Inc
Industrial Air Products Co.
Industrial Gloves Co.
International Shoe Co.
Johns-Manville
Judsen Rubber Works, Inc.
Keasbey & Mattison Co.
Miller Equipment Co., Inc.
MINE SAFETY APPLIANCES CO.
Parker Safety Equipment Co.
Penn Mfg. & Supply Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pulmosan Safety Equipment Corp.
Rose Mfg. Co.
Safety Clothing & Equipment Co.
Safety First Shoe Co., Inc.
Safety First Supply Co.
Snyder & Son, Inc., M. L.
U. S. Rubber Co.
Wilson Rubber Co.

Safety Equipment & Accessories—does not include: Safety Clothing; Safety Goggles & Masks; Safety Posters; Safety Respirators. Also see: Fire Fighting; First Aid

Wolf Safety Lamp Co. of America, Inc.

SAFETY GOGGLES & MASKS

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
American Optical Co.
Bausch & Lomb Optical Co.
Binks Mfg. Co.
Bullard Co., E. D.
Chicago Eye Shield Co.
Industrial Air Products Co.
Johns-Manville
MINE SAFETY APPLIANCES CO.
Parker Safety Equipment Co.
Pulmosan Safety Equipment Corp.
Ray-O-Vac Co.
Safety Clothing & Equipment Co.
Scott Aviation Corp.
Sellstrom Mfg. Co.
U. S. Safety Service Co.
Willson Products Div. Ray-O-Vac Co.

(SAFETY POSTERS—see Signs)

SAFETY RESPIRATORS

American Optical Co.
Binks Mfg. Co.
Bullard Co., E. D.
Flexo Products, Inc.
MINE SAFETY APPLIANCES CO.
Pulmosan Safety Equipment Corp.
Ray-O-Vac Co.
Safety Clothing & Equipment Co.
Scott Aviation Corp.

SAMPLERS, ORE, CONCENTRATE, ETC. (MECHANICAL)

Canadian Locomotive Co., Ltd.
CARPCO MANUFACTURING, INC.
COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO.
Dagley Mfg. Co.
DENVER EQUIPMENT CO.
GALIGHER CO.
HARDINGE CO., INC.
Heyl & Patterson, Inc.
LEDOUX & CO.
Machinery Center Inc.
STURTEVANT MILL CO.

(SAWS—see below; also see Tools)

SAWS, CONCRETE & MASONRY

Clipper Mfg. Co.

SCALES, AUTOMATIC WEIGHING—also see Feeders

Aerofall Mills, Inc.
Buffalo Scale Co., Inc.
Butler Bin Co.
Consolidated Packaging Machinery Corp.
Dwight-Lloyd Div. McDowell Co., Inc.
Erie Strayer Co.
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
Industrial Physics & Electronics Co.
McDowell Co., Inc.
MERRICK SCALE MFG. CO.
Revere Corp. of America
SCHAFFER POIDOMETER CO.
Streeter-Amet Co.
Taller & Cooper, Inc.
Thurman Machine Co.
Toledo Scale Co.
Torsion Balance Co.
Trans-Weigh Corp.
Voland & Sons, Inc.
Webb Corp.
Wellman Engineering Co. McDowell Enterprise

SCALES, PLATFORM

Bonded Scale & Machine Co.
Buffalo Scale Co., Inc.
Chatillon & Sons, John
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
Revere Corp. of America
Richardson Scale Co.
Streeter-Amet Co.
Taller & Cooper, Inc.
Thurman Machine Co.
Toledo Scale Co.
Webb Corp.

SCALES, SACKING

Bemis Bro. Bag Co.
Consolidated Packaging Machinery Corp.
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
Richardson Scale Co.
Toledo Scale Co.

SCALES, WEIGHT HOPPER—also see Feeders

Atlas Car & Mfg. Co.
Buffalo Scale Co., Inc.
Butler Bin Co.
Erie Strayer Co.
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
Nolan Co.
Richardson Scale Co.
Streeter-Amet Co.
Taller & Cooper, Inc.
Thurman Machine Co.
Toledo Scale Co.
Webb Corp.

(SCINTILLATION COUNTERS—see Radiation Detectors)

(SCRAPERS, DRAGLINE—see: Buckets, Dragline Scraper-Slusher; Hoists, Dragline Scraper-Slusher; Excavators, Dragline Tower)

SCRAPERS WHEELED, SELF-PROPELLED & TOWED (Earthmoving)

ALLIS CHALMERS MFG. CO. CONSTRUCTION MACHY. DIV.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Tractor Equipment Corp.
Ateco Div. Greenville Steel Car Co.
Caterpillar Tractor Co.
Clark Equipment Co. Construction Machinery Div.
Euclid Div. General Motors Corp.
International Harvester Export Co.
Landis Steel Co.
LE TOURNEAU-WESTINGHOUSE CO.
Oliver Corp.
Wooldridge Mfg. Div. Continental Copper & Steel Industries Inc.

(SCREEN CLOTH—see Wire Cloth)

SCREEN ECCENTRICS & VIBRATORS—also see Vibrators

Diamond Iron Works Div. Goodman Mfg. Co.
HEWITT-ROBINS, INC.
IOWA MFG. CO.
LINK-BELT CO. DEPT. EMJ-57
Machinery Center Inc.
Tyler Co., W. S.

SCREEN HEATERS

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Diester Concentrator Co.
HEWITT-ROBINS, INC.
LINK-BELT CO. DEPT. EMJ-57
Screen Equipment Co., Inc.
Tyler Co., W. S.

SCREEN PLATES & SHEET

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
CARD IRON WORKS, C. S.
Chicago Perforating Co.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Manganese Steel Forge Co.
McNally Pittsburg Mfg. Corp.
Multi-Metal Wire Cloth Co., Inc.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Yuba Manufacturing Co.

SCREEN, WIRE & BAR

BIXBY-ZIMMER ENGR. CO.
Buffalo Wire Works Co.
Chain Belt Co.
Colorado Fuel & Iron Corp.
Dorr Oliver, Inc.
HEWITT-ROBINS, INC.
Hoyt Wire Cloth Co.
IOWA MFG. CO.
Korb-Pettit Wire Fabrics & Iron Works
LINK-BELT CO. DEPT. EMJ-57
Ludlow-Saylor Wire Cloth Co.
Manganese Steel Forge Co.
McNally Pittsburg Mfg. Corp.
Newark Wire Cloth Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Specialty Engineering Co.
Tyler Co., W. S.
WEDGE WIRE CORP.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

SCREENS, ELECTRICALLY HEATED

Acme Road Machinery Co., Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Deister Concentrator Co.
Deister Machine Co.
HEWITT-ROBINS, INC.
LINK-BELT CO. DEPT. EMJ-57
Overstrom & Sons, Inc.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Productive Equipment Corp.
Screen Equipment Co., Inc.
SIMPLICITY ENGINEERING CO.
Syntron Co.
Tyler Co., W. S.
Universal Vibrating Screen Co.

SCREENS, GRAVITY

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Chicago Perforating Co.
Hendrick Mfg. Co.
Laubenstein Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Newark Wire Cloth Co.
Nolan Co.
STEARNS ROGER MFG. CO.
Tyler Co., W. S.
Universal Road Machinery Co.
WEDGE WIRE CORP.

SCREENS, REVOLVING (TROMMEL)

Acme Road Machinery Co., Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Bartlett & Snow Co., C. O.
Bodinson Manufacturing Co., Inc.
CARD IRON WORKS, C. S.
Chicago Perforating Co.
Davis Foundry & Machine Works
Diamond Iron Works Div., Goodman Mfg. Co.
DIESEL ENERGY CORP.
Gruendler Crusher & Pulverizer Co.
Hack Engineeing Co.
Hendrick Mfg. Co.
Laubenstein Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
McLanahan & Stone Corp.
Minerals Engineering Co.
NATIONAL IRON CO.

Pioneer Engineering Div. Poor & Co. Inc.
Newark Wire Cloth Co.
Rogers Iron Works Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
TRAYLOR ENGINEERING & MFG. CO.
Tyler Co., W. S.
Universal Dredge Mfg. Co.
Universal Road Machinery Co.
Washington Iron Works
Washington Machinery Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Yuba Manufacturing Co.

SCREENS, SHAKING & VIBRATING

Acme Road Machinery Co., Inc.
Aerofall Mills, Inc.
ALLIS CHALMERS MFG CO. INDUSTRIES GROUP
Bonded Scale & Machine Co.
Buffalo Wire Works Co.
C & D Div. Yuba Manufacturing Co.
Cambridge Wire Cloth Co.
Canadian Locomotive Co., Ltd.
CARPCO MANUFACTURING, INC.
Chicago Perforating Co.
Daniels Co. Contractors, Inc.
Davis Foundry & Machine Works
Deister Concentrator Co.
Deister Machine Co.
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
DIESEL ENERGY CORP.
Dorr Oliver, Inc.
DRAVO CORP.
Exolon Co.,
Fahrenwald Co., A. W.
Gilson Screen Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
Hendrick Mfg. Co.
HEWITT-ROBINS, INC.
Industrial Engrg. & Construction Co.
IOWA MFG. CO.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
Lecco Machinery & Engineering Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Multi-Metal Wire Cloth Co., Inc.
Newark Wire Cloth Co.
NORDBERG MFG. CO.
Overstrom & Sons, Inc.
Patterson Foundry & Machine Co.
Pioneer Engineering Div. Poor & Co. Inc.
Prins & Associates, K.
Productive Equipment Corp.
Ridge Equipment Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc
Rogers Iron Works Co.
Savage Co., W. J.
Screen Equipment Co., Inc.
SIMPLICITY ENGINEERING CO.
Smith Engineering Works
Southwestern Engineering Co.
Specialty Engineering Co.
STEARNS ROGER MFG. CO.
Stephens-Adamson Mfg. Co.
STURTEVANT MILL CO.
Syntron Co.
Tyler Co., W. S.
Universal Dredge Mfg. Co.
Universal Vibrating Screen Co.
WEDGE WIRE CORP.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Williams Patent Crusher & Pulverizer Co

(SCRUBBERS, ENGINE EXHAUST—see Engine Exhaust Scrubbers)

SCRUBBERS, AIR & WASTE GAS—also see: Dust Collectors; Gas Separation Process Equipment

Arrow Tank Co.
Atlantic Tank Corp.
Black, Sivalls & Bryson, Inc.
Chemical Construction Corp.
Dorr Oliver, Inc.
Ducon, Inc.
Graver Tank & Mfg. Co., Inc.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
Johnson-March Corp.
Mahon Co., R. C.
McNally Pittsburg Mfg. Corp.
National Tank & Pipe Co.
Santa Fe Tank Div. Fluor Products Co.
Schneible Co., Claude B.
Standard Steel Corp.

SCRUBBERS & WASHERS, MINERAL —also see: Agitators, Washing Plants

Acme Road Machinery Co., Inc.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
Bodinson Manufacturing Co., Inc.
BOOTH CO.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
EAGLE IRON WORKS
Georgia Iron Works Co.
Gruendler Crusher & Pulverizer Co.
Hack Engineering Co.
HARDINGE CO., INC.
Hirsch Bros. Machy. Co.
IOWA MFG. CO.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
McLanahan & Stone Corp.
Meckum Engineering, Inc.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Pioneer Engineering Div. Poor & Co. Inc.
Rogers Iron Works Co.
Simplicity System Co.
Smith Engineering Works
STEARNS ROGER MFG. CO.
Tyler Co., W. S.
Universal Dredge Mfg. Co.
Universal Engineering Corp.
Universal Road Machinery Co.
WESTERN MACHINERY CO.
Yuba Manufacturing Co.

(SEPARATORS & CONCENTRATORS—see below; also see: Amalgamating Process Equipment (special); Asbestos Milling Equipment (special); Classifiers; Cyaniding Process Equipment (special); Diamond Concentrating Equipment (special); Filters; Flotation Machines; Gas Separation Equipment (special); Ion Exchange equiomment (special); Kilns; Retorts and Distillation Equipment; Screens; Scrubbers; Solvent Extraction Equipment (special); Thickeners)

SEPARATORS, ELECTROSTATIC & HIGH TENSION

CARPCO MANUFACTURING, INC.
Engineers Syndicate, Ltd.
Exolon Co.,
Sutton Steele & Steele, Inc.

SEPARATORS, HEAVY MEDIA

COLORADO IRON WORKS CO. A SUBSIDIARY OF MINE & SMELTER SUPPLY CO.
Daniels Co. Contractors, Inc.
DIESEL ENERGY CORP.
DINGS MAGNETIC SEPARATOR CO.
EAGLE IRON WORKS
Fuel Process Co.
HARDINGE CO., INC.
Jeffrey Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Magnetic Engineering & Mfg. Co.
McNally Pittsburg Mfg. Corp.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Ore & Chemical Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Southwestern Engineering Co.
STEARNS MAGNETIC PRODUCTS
WESTERN MACHINERY CO.

SEPARATORS, JIG DRY

Bico Inc.
DIESEL ENERGY CORP.
Jeffrey Mfg. Co.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc.
Sutton Steele & Steele, Inc.

SEPARATORS, JIG, WET

Davis Foundry & Machine Works
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Dorr Oliver, Inc.
Hirsch Bros. Machy. Co.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & Eng. CORP.
LINK-BELT CO. DEPT. EMJ-57
Machinery Center Inc.
Mclanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Prime & Associates, K.
WESTERN MACHINERY CO.
Yuba Manufacturing Co.

SEPARATORS, MAGNETIC, BELT & DRUM

CARPCO MANUFACTURING, INC.
CRUCIBLE STEEL CO. OF AMERICA
Daniels Co. Contractors, Inc.
DIESEL ENERGY CORP.
DINGS MAGNETIC SEPARATOR CO.
Engineers Syndicate, Ltd.
Exolon Co.
Homer Mfg. Co.
Jeffrey Mfg. Co.
Magnetic Engineering & Mfg. Co.
Schrader Co., F. W.
STEARNS MAGNETIC PRODUCTS

SEPARATORS, SHAKING TABLE, WET

CARPCO MANUFACTURING, INC.
Dagley Mfg. Co.
Deister Concentrator Co.
Deister Machine Co.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Jeffrey Mfg. Co.
KENNEDY-VAN SAUN MFG. & ENG. Corp.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.

SEPARATORS, SHAKING TABLE, DRY (AIR)

DIESEL ENERGY CORP.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. Dept. EMJ-57
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc
STURTEVANT MILL CO.
Wilkerson Corp.
Williams Patent Crusher & Pulverizer Co.

SEPARATORS, SLUICE (TROUGH) SPIRAL & SIMILAR FILM GRAVITY TYPES

CARPCO MANUFACTURING, INC.
DIESEL ENERGY CORP.
LINK-BELT CO. DEPT. EMJ-57

(SHAFT MUCKING MACHINES—see Loaders, Special Mine Shaft Mucking)

SHEAVES—see below; also see Blocks)

SHEAVES, MINE HOIST

AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Hoist & Derrick Co.
CARD IRON WORKS, C. S.
Connellsville Mfg. & Mine Supply Co.
Dick Co., R. & J.
Farrell-Cheeck Steel Co.
Frog, Switch & Mfg. Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Irwin Foundry & Mine Car Co
JOY MFG. CO.
Lake Shore, Inc.
Madesco Tackle Block Co.
MAYO TUNNEL & MINE EQUIPMENT CO.
McMillan's Sons, W. H.
NATIONAL IRON CO.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Ogden Iron Works
Princeton Griphoist, Inc.
Rogers Iron Works Co.
Skookum Co., Inc.
Tool Steel Gear & Pinion Co.
Vulcan Iron Works
VULCAN IRON WORKS CO., (DENVER)
West Virginia Armature Co.
Western Block Co.
Wood's Sons Co., T. B.
Worthington Corp.
Yuba Manufacturing Co.

(SHOVELS—See Excavators)

(SHUTTLE CARS—see Trucks, Shuttle Car)

(SIEVES—see below; also see Screens)

SIEVES, TESTING

Central Scientific Co.
Fahrenwald Co., A. W.
Laubenstein Mfg. Co.
Newark Wire Cloth Co.
Tyler Co., W. S.

(SIGNALS—see Communication)

SIGNS — POSTERS

Brady Co., W. H.
Dicke Tool Co.
Elliott Service Co., Inc.
MINE SAFETY APPLIANCES CO.
Safety Clothing & Equipment Co.

SINTERING EQUIPMENT (SPECIAL)—does not include: Furnaces; Kilns; Nodulizing Equipment.

BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
DRAVO CORP.
Dwight-Lloyd Div. McDowell Co., Inc.
Hauck Manufacturing Co.
Heyl & Patterson, Inc.
Koppers Co. Inc.
MACE CO.
McDowell Co., Inc.
Mead Mill Co.
NATIONAL MALLEABLE & STEEL CASTINGS CO.
Sanford-Day Iron Works, Inc.
Tool Steel Gear & Pinion Co.
Wellman Engineering Co. McDowell Enterprise

SKIPS & CAGES (MINE HOIST)—does not include Buckets, Hoisting & Sinking

CARD IRON WORKS, C. S.
Connellsville Mfg. & Mine Supply Co.
DENVER EQUIPMENT CO.
Easton Car & Construction Co.
Helmick Foundry-Machine Co.
Hirsch Bros. Machy. Co.
Holmes & Bros., Inc. Robert
Lake Shore, Inc. Lake Shore Engineering Div.
Landis Steel Co.
Machinery Center Inc.
MAYO TUNNEL & MINE EQUIPMENT CO.
Miners' Hardware Supply Co.
NATIONAL IRON CO.
Nolan Co.
NORDBERG MFG. CO.
Ogden Iron Works
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc
Rogers Iron Works Co.
STEARNS ROGER MFG. CO.
Telluride Iron Works Co.
Vulcan Iron Works
VULCAN IRON WORKS CO., (DENVER)

(SLUSHERS—see: Buckets, Dragline Scraper-Slusher; Hoists, Dragline Scraper-Slusher)

SOLVENT EXTRACTION PROCESS EQUIPMENT (SPECIAL)—does not include standard auxiliary equipment

ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
DENVER EQUIPMENT CO.
Santa Fe Tank Div. Fluor Products Co.
Turbo-Mixer Div. General American Transportation Corp.

SPECTROSCOPIC INSTRUMENTS

American Instrument Co., Inc.
American Optical Co.
Bausch & Lomb Optical Co.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Fisher Scientific Co.
Jarrell-Ash Co.

(SPEED REDUCERS & INCREASERS —see Drives)

(SPROCKETS—see Gears)

STEEL (PLATES, SHAPES, ETC.)—does not include: Buildings, Prefab; Castings; Drill Steel; Forgings; fencing; Mine Supports; Pipe); Screen; Tanks; Wire

Allegheny Ludlum Steel Corp.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Beall Pipe & Tank Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Carpenter Steel Co.
CRUCIBLE STEEL CO. OF AMERICA
Foster Co., L. B.
Holmes & Bros., Inc. Robert
Industrial Engr. & Construction Co.
Inland Steel Co.
Jessop Steel Co.
JONES & LAUGHLIN STEEL CORP.
Kanawha Mfg. Co.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Midvale-Heppenstall
Moran Engineering Co.
Republic Steel Corp.
Ogden Iron Works
PITTSBURGH STEEL CO.
Ryerson & Son, Inc., Joseph T.
Sheffield Div. Armco Steel Corp.
Simonds Saw and Steel Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Wickwire Spencer Steel Div.
COLORADO STEEL & IRON CORP.
Wood Steel Co., Alan
Youngstown Sheet & Tube Co.

STEEL, ALLOY (PLATES, SHAPES, ETC.)—does not include: Castings Drill Steel; Forgings; Mine Supports; Pipe; Screen; Tanks; Wire

Allegheny Ludlum Steel Corp.
AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
American Steel Foundries
Atlas Steels, Ltd.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Carpenter Steel Co.
CRUCIBLE STEEL CO. OF AMERICA
Dominion Steel & Coal Corp., Ltd.
Electric Steel Foundry Co.
Jessop Steel Co.
JONES & LAUGHLIN STEEL CORP.
Kanawha Mfg. Co.
Kellog Co., M. W.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Manganese Steel Forge Co.
Midvale-Heppenstall
Moran Engineering Co.
Republic Steel Corp.
Ryerson & Son, Inc., Joseph T.
Sheffield Div. Armco Steel Corp.
Simonds Saw & Steel Co.
Tennessee Coal & Iron Div. U. S. Steel Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Vanadium-Alloys Steel Co.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Wood Steel Co., Alan
Youngstown Sheet & Tube Co.

(STEEL MINE SUPPORTS & CIRCULAR SETS—see Mine Supports)

STUD DRIVERS

DuPont de Nemours & Co., E. I.
Thor Power Tool Co.

(SULPHUR WELL EQUIPMENT—see Salt & Sulphur)

SURVEYING EQUIPMENT & SUPPLIES—also see: Drafting Equipment & Supplies; Transits, Pocket

American Paulin System
Berger & Sons, C. L. Inc.
Black Diamond Spad Co.
Bruning Co., Inc. Charles
Brunson Instrument Co.
Geo-Optic Co., Inc.
Geophysical Instrument & Supply Co.
Gurley, W. & L. E.
KERN INSTRUMENTS, INC.
Keuffel & Esser Co.
Post Co., Frederick
Suverkrop Instruments
Warren-Knight Co.
White, Instrument Co., David.
Wild Heerbrugg Instruments, Inc.

(SURVEYORS—see Contractors)

T

(TACHOMETERS—see Meters, Speed)

TANKS, LINED—see below; also see: Coatings; Linings

Aluminum Co. of America
American Hard Rubber Co.
Arrow Tank Co.
Beall Pipe & Tank Corp.
DENVER EQUIPMENT CO.
Gates Engrg. Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Hauser-Stander Tank Co.
Kirk & Blum Mfg. Co.
Patterson Foundry & Machine Co.
U. S. Rubber Co. Mechanical Goods Div.

TANKS, LINED, SPECIAL METAL

Aluminum Co. of America
Ampco Metal, Inc.
Arrow Tank Co.
Beall Pipe & Tank Corp.
Beech Aircraft Corp.
Canadian Locomotive Co., Ltd.
Chattanooga Boiler & Tank Co.
Graver Tank & Mfg. Co., Inc.
Kirk & Blum Mfg. Co.
Klemp Metal Grating Corp.
National Lead Co.
Process Engineering, Inc.

TANKS, LINED, CERAMIC, CONCRETE, GLASS, ETC.

Beall Pipe & Tank Corp.
Butler Manufacturing Co.
Carrier Conveyor Corp.
Ogden Iron Works
Patterson Foundry & Machine Co.
Pennsalt Chemicals Corp.
Process Engineering, Inc.
Smith Co., A. O.
Thermoid Co. Industrial Div.

TANKS, LINED, PLASTIC OR RUBBER

American Hard Rubber Co.
Arrow Tank Co.
Beall Pipe & Tank Corp.
BOOTH CO.
Canadian Locomotive Co., Ltd.
Chattanooga Boiler & Tank Co.
DENVER EQUIPMENT CO.
GALIGHER CO.
Gates Engrg. Co.
Goodall Rubber Co.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Graver Tank & Mfg. Co., Inc.
Kirk & Blum Mfg. Co.
LINATEX CORP. OF AMERICA
Luzerne Rubber Co.
Process Engineering, Inc.
STEARNS ROGER MFG. CO.
U. S. Rubber Co. Mechanical Goods Div.
Yaun Mfg. Co., Inc.

TANKS, STEEL—also see Bins

Beall Pipe & Tank Corp.
Bethlehem Steel Co., Inc.
Black, Sivalls & Bryson, Inc.
Bodinson Manufacturing Co., Inc.
Butler Manufacturing Co.
Canadian Locomotive Co., Ltd.
Chattanooga Boiler & Tank Co.
Chicago Bridge & Iron Co.
Columbian Steel Tank Co.
Condenser Service & Engineering Co.
Connellsville Mfg. & Mine Supply Co.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
Dominion Steel & Coal Corp., Ltd.
Enterprise Wheel & Car Corp.
Erie Strayer Co.
Graver Tank & Mfg. Co., Inc.
Holmes & Bros., Inc. Robert
Industrial Engrg. & Construction Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Keeler Co., E.
Kirk & Blum Mfg. Co.
Lakeside Bridge & Steel Co.
Mahon Co., R. C.
Ogden Iron Works
Ottumwa Box Car Loader Co.
Process Engineering, Inc.
STEARNS ROGER MFG. CO.
Vulcan Iron Works
Wheeler Mfg. Co., C. H.
Yaun Mfg. Co., Inc.

TANKS, WOOD—also see Bins

Acme Tank Mfg. Co.
Arrow Tank Co.
Atlantic Tank Corp.
Black, Sivalls & Bryson, Inc.
Caldwell Co., W. E.
DENVER EQUIPMENT CO.
Hall & Sons, Amos H.
Hauser-Stander Tank Co.
MORSE BROS. MACHINERY CO.
National Tank & Pipe Co.
Pacific Wood Tank Corp.
Santa Fe Tank Div. Fluor Products Co.
Stulz-Sickles Co.
Windeler Co., Ltd., George

TARPAULINS & TENTING

AMERICAN BRATTICE CLOTH CORP.
Bemis Bro. Bag Co.
Daniels, Inc., C. R.
Goodrich Industrial Products Co., B. F.
Irvington Div. Minnesota Mining & Mfg. Co.
Parker Safety Equipment Co.
Paulsen-Webber Cordage Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Safety Clothing & Equipment Co.
Snyder & Son, Inc., M. L.
Turner Halsey Co.

(TELEPHONES—see Communications)

(TELEVISION—see Communications)

(THERMOMETERS & THERMOCOUPLES—see Meters, Temperature)

THICKENERS—also see: Classifiers; Filters; Separators; Screens

Dagley Mfg. Co.
DENVER EQUIPMENT CO.
DIESEL ENERGY CORP.
Dorr Oliver, Inc.
EIMCO CORP.
Graver Water Conditioning Co.
HARDINGE CO., INC.
Heyl & Patterson, Inc.
Hirsch Bros. Machy. Co.
Infilco, Inc.
KENNEDY-VAN SAUN MFG. & ENG. CORP.
LINK-BELT CO. DEPT. EMJ-57
Machinery Center Inc.
MORSE BROS. MACHINERY CO.
WESTERN MACHINERY CO.

TIMBER CONNECTORS, SPECIAL—does not include Fasteners

TIMBER FRAMING MACHINES

DENVER EQUIPMENT CO.
STEARNS ROGER MFG. CO.
Timber Engineering Co.

TIMBER PRESERVATIVES

Baxter & Co., J. H.
C—A Wood Preserver Co.
Carbolineum Wood Preserving Co.
Darworth, Inc.
Dow Chemical Co.
DuPont de Nemours & Co., E. I.
Koppers Co. Inc.
Osmose Wood Preserving Co.
Quigley Co., Inc.
Reilly Tar & Chemical Corp.

TIMBERING MACHINES

Fletcher & Co., J. H.

TIRES & TUBES

Armstrong Rubber Co.
GATES RUBBER CO.
Goodrich Co., B. F. Truck & Bus Tire Dept.
Goodrich Industrial Products Co., B. F.
Goodyear Tire & Rubber Co.
Goodyear Tire & Rubber Co. Industrial Products
Seiberling Rubber Co.
U. S. Rubber Co.

TOOLS, HAND & POWER—does not include: Car Detrailers & Rerailers; Car Movers, Hand; Hoists, Life, Hand Chain; Jacks; Rail Benders; Track Gage-Rods & Levels; Machine Shop Equipment, Powered (Lathes, etc.); Lubricating Equipment; Car Wheel & Gear Pullers; Concrete Placers; Kiln & Industrial Guns; Stud Drivers; Rail Drills & Punches; Timbering Machines

Ames Co., O.
Black & Decker Mfg. Co.
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC.
Burndy Corp.
CHICAGO PNEUMATIC TOOL CO.
Dicke Tool Co.
Electric Materials Co.
General Steel Warehouse Co., Inc.
Glensco Tool Div.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Greene, Tweed & Co.
Ideal Industries, Inc.
INGERSOLL-RAND CO.
Interstate Drop Forge Co.
Leavitt Machine Co.
Leetonia Tool Co.
Long Co.
Lufkin Rule Co.
Milwaukee Electric Tool Corp.
Nelson Stud Welding
Newcomer Products, Inc.
Owatonna Tool Co.
Patton Mfg. Co., Inc.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Porter-Cable Machine Co.
Proto Tool Co.
Reed Roller Bit Co.
REMINGTON ARMS CO. INC.
Simonds Saw and Steel Co.
Skookum Co., Inc.
Snap-on-Tools Corp.
Stanley Electric Tool Div. Stanley Works
Star Expansion
Swett Iron Works, A. L.
Thor Power Tool Co.
Toledo Pipe Threading Machine Co.
U. S. Electrical Tool Co.
VULCAN IRON WORKS CO., (DENVER)
Willey's Carbide Tool Co.
Wodack Electric Tool Corp.
Wood Shovel & Tool Co.
Wright Power Saw & Tool Corp. Subsidiary of Thomas Industries

(TORQUE CONVERTERS—see Drives)

(TRACK—see below; also see Rail. . .)

TRACK CLEANING MACHINES

AMERICAN MINE DOOR CO.
Frank, M. K.
NORDBERG MFG. CO.

TRACK GAGE-RODS & LEVELS

ALDON CO.
Coover Railroad Track Brace Co.
Foster Co., L. B.
Frank, M. K.
Gibraltar Equipment & Mfg. Co.
NORDBERG MFG. CO.

TRACK SHIFTER, LAYING & OTHER MACHINES

Frank, M. K.
NORDBERG MFG. CO.
Templeton, Kenly & Co.

TRACTORS, CRAWLER

ALLIS CHALMERS MFG. CO. CONSTRUCTION MACHY. DIV.
ALLIS CHALMERS MFG CO. INDUSTRIES GROUP
Case Co., J. I.
Caterpillar Tractor Co.
EIMCO CORP.
Euclid Div. General Motors Corp.
International Harvester Export Co.
Oliver Corp.
Schroeder Brothers

TRACTORS, WHEELED—does not include Truck Tractors; also see Car Movers

ALLIS CHALMERS MFG. CO. CONSTRUCTION MACHY. DIV.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Coleman Co.
Caterpillar Tractor Co.
Easton Car & Construction Co.
Four Wheel Drive Auto Co.
Hough Co., Frank G.
International Harvester Export Co.
LE TOURNEAU-WESTINGHOUSE CO.
Oliver Corp.
Pettibone Mulliken Corp.
Sheppard Co., Inc., R. H.
Silent Hoist & Crane Corp.
Tractomotive Corp.
WESTINGHOUSE AIR BRAKE CO.

TRACTOR ATTACHMENTS—also see Loaders

ALLIS CHALMERS MFG. CO. CONSTRUCTION MACHY. DIV.
ALLIS CHALMERS MFG CO. INDUSTRIES GROUP
American Tractor Equipment Corp.
Arrow Mfg. Co.
Ateco Div. Greenville Steel Car Co.
Balderson Inc.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
Clark Equipment Co. Construction Machinery Div.
Drott Mfg. Co.
EIMCO CORP.
Electric Steel Foundry Co.
Gar Wood Industries, Inc.
Hales Co., W. M.
Hyster Co.
International Harvester Export Co.
LE TOURNEAU-WESTINGHOUSE CO.
Oliver Corp.
Skookum Co., Inc.
Tractomotive Corp.
WESTINGHOUSE AIR BRAKE CO.

TRACTOR & EARTHMOVING EQUIPMENT WEAR-REPLACEMENT PARTS

ALLIS CHALMRS MFG. CO. CONSTRUCTION MACHY. DIV.
ALLIS CHALMERS MFG CO INDUSTRIES GROUP
Alloy Steel & Metals Co.
AMERCAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIV.
Case Co., J. I. Industrial Div.
Caterpillar Tractor Co.
EIMCO CORP.
Electric Steel Foundry Co.
Frog, Switch & Mfg. Co.
Gar Wood Industries, Inc.
Gatke Corp.
Euclid Div. General Motors Corp.
Hales Co., W. M.
Machinery Center Inc.
Rockwell Spring & Axle Co. Timken-Detroit Axle Div.
Sorel Steel Foundries, Ltd.
Sterling Steel Casting Co.
Thew Shovel Co.
Tool Steel Gear & Pinion Co.
U. S. Rubber Co.
Wellman Co., S. K.

TRAMP IRON DETECTORS

General Equipment & Mfg. Co.
Industrial Physics & Electronics Co.

TRANSITS, POCKET

AINSWORTH & SONS, WILLIAM
Bruning Co., Inc. Charles
Engineers Syndicate, Ltd.
Geo-Optic Co., Inc.
Geophysical Instrument & Supply Co.
Keuffel & Esser Co.
Suverkrop Instruments

(TRANSMISSIONS—see Drives)

(TROLLEY (ELECTRICAL HAULAGE) ACCESSORIES—see Electric Trolley Accessories)

TRUCK (& TRACTOR) TRAILERS & WAGONS—also see Scrapers

ALLIS CHALMERS MFG. CO. CONSTRUCTION MACHY. DIV.
Arrow Mfg. Co.
ATHEY PRODUCTS CORP.
Beall Pipe & Tank Corp.
C & D Div. Yuba Manufacturing Co.
Cline Truck Co.
Easton Car & Construction Co.
Euclid Div. General Motors Corp.
F. A. B. Mfg. Co.
Fairbanks Co.
Four Wheel Drive Auto Co.
Fruehauf Trailer Co.
Hendrickson Mfg. Co.
International Harvester Export Co.
Irwin Foundry & Mine Car Co.
LE TOURNEAU-WESTINGHOUSE CO.
Maxi Corp.
Rogers Brothers Corp.
Salem-Brosius, Inc.
Schonrock Mfg. Co.
Truck Engineering Corp.
WINTER WEISS CO.

TRUCK & TRAILER BODIES

Anthony Co.
Beall Pipe & Tank Corp.
Butler Manufacturing Co.
Cline Truck Co.
Easton Car & Construction Co.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Gramm Trailer Corp.
Heil Co.
Hockensmith Corp.
International Harvester Export Co.
Landis Steel Co.
Marion Metal Products Co.
Schonrock Mfg. Co.
Transport Trailers, Inc.
Truck Engineering Corp.
WINTER WEISS CO.

(TRUCK & TRAILER DUMPING DEVICES—see Car (& Truck) Dumping Devices)

TRUCKS & TRUCK TRACTORS—also see: Scrapers; Trucks, Shuttle Car

American Coleman Co.
Chrysler Corp. Dodge Truck Div.
Cline Truck Co.
DART TRUCK CO.
F. A. B. Mfg. Co.
Four Wheel Drive Auto Co.
Euclid Div. General Motors Corp.
Federal Motor Truck Div. Napco Industries Inc.
Ford Motor Co.
Getman Brothers
Hendrickson Mfg. Co.
International Harvester Co. Motor Truck Div.
International Harvester Export Co.
Kenworth Motor Truck Co. Div. Pacific Car and Foundry Co.
LE TOURNEAU-WESTINGHOUSE CO.
Mack Trucks, Inc.
Marmon-Herrington Co.
Oshkosh Motor Truck, Inc.
Reo Motors, Inc.
Walter Motor Truck Co.
WESTINGHOUSE AIR BRAKE CO.
Willys Motors, Inc.

TRUCKS, LIFT, FORK & PLATFORM

ALLIS-CHALMERS MFG. CO. BUDA DIV.
ALLIS CHALMERS MFG. CO. INDUSTRIES GROUP
American Pulley Co.
Baker-Raulang Co.
Easton Car & Construction Co.
Four Wheel Drive Auto Co.
Hyster Co.
Kurk-Mix Co., Koehring Div.
Lamson Corp.
Prime Mover Co.
Silent Hoist & Crane Corp.
Uhrden, Inc.
Yale & Towne Mfg. Co. Yale Materials Handling Div.

TRUCKS, SHUTTLE CAR

Easton Car & Construction Co.
Electric Steel Foundry Co.
Getman Brothers
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
JOY MFG. CO.
Salem-Brosius, Inc.

(TUBING, METAL—see Pipe)

(TURBINES—see Engines)

U

ULTRAVIOLET LIGHTS

CARPCO MANUFACTURING, INC.
Detectron Corp.
Engineers Syndicate, Ltd.
Fisher Research Laboratory, Inc.
Geophysical Instrument & Supply Co.
Macbeth Daylighting Corp.
Menlo Research Laboratory
Mt. Sopris Instrument Co.
Sylvania Electric Products, Inc.
Ultra-Violet Products, Inc.
Whites Electronics

UNLOADERS, R. R., CAR & TRUCK

BARBER-GREENE CO.
Convair, Inc.
DRAVO CORP.
Easton Car & Construction Co.
Erie Strayer Co.
Frank, M. K.
General American Transportation Corp.
HEWITT-ROBINS, INC.
Heyl & Patterson, Inc.
Hough Co., Frank G.
Jeffrey Mfg. Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Oliver Corp. A. B. Farquhar Div.
Richardson Scale Co.
Stephens-Adamson Mfg. Co.
Webster Mfg., Inc.

V

VALVES

Alco Products, Inc.
ALLEN-SHERMAN-HOFF PUMP CO.
American Chain & Cable Co., Inc. R-P&C Valve Div.
American Hard Rubber Co.
Automatic Switch Co.
Bailey Meter Co.
Barrett Haentjens & Co.
Black, Sivalls & Bryson, Inc.
Bristol Co.
Cash Co., A. W.
Clark Controller Co.
Conrader Co., Inc., R.
Crane Co.
Crosby Valve & Gage Co.
Darling Valve & Mfg. Co.
DeZurik Corp.
Dick Co., R. & J.
Dixon Valve & Coupling Co.
Durlron Co., Inc.
Edward Valves, Inc.
Electric Steel Foundry Co.
Elkhart Brass Mfg. Co., Inc.
EQUIPMENT ENGINEERS INC.
Everlasting Valve Co.
Fairbanks Co.
Falcon Alarm Co., Inc.
Farris Flexible Valve Corp.
Fisher & Porter Co.
Foster Co., L. B.
Galland Henning Mfg. Co. Nopak Div.
Golden-Anderson Valve Specialty Co.
Goodrich Industrial Products Co., B. F.
Goyne Pump Co.
GRINNELL CO., INC.
Hamer Valves, Inc.
HEWITT-ROBINS, INC.
Hills-McCanna Co.
Hunt & Son, Inc., C. B.
Jenkins Bros.
Johnson Corp.
Kennedy Valve Mfg. Co.
Kieley & Mueller, Inc.
Klipfel Valves, Inc.
Ledeen, Inc.
LE-HI Div. Hose Accessories Co.
LINATEX CORP. OF AMERICA
Lonergan Co., J. E.
Lunkenheimer Co.
Luzerne Rubber Co.
McDonald Mfg. Co., A. Y.
McNally Pittsburg Mfg. Corp.
Minneapolis-Honeywell Regulator Co.
Minneapolis-Honeywell Regulator Co. Industrial Div.
MINE & SMELTER SUPPLY CO. MARCY MILL DIV.
Mueller Brass Co.
Ohio Brass Co.
Ohio Injector Co.
Okadee Co.
Pennsylvania Pump & Compressor Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Powell Co., Wm.
Red Jacket Co., Inc.
Republic Flow Meters Co.
Rockwell Mfg. Co.
Rockwell Co., W. S.
Stockham Valves & Fittings
U. S. Rubber Co.
U. S. Rubber Co. Mechanical Goods Div.
Vickers Inc.
Walworth Co.
Weatherhead Co. Fort Wayne Div.
Wellman Engineering Co. McDowell Enterprise
Western Precipitation Corp.
WESTINGHOUSE AIR BRAKE CO.
WESTINGHOUSE AIR BRAKE CO. IND. PRODUCTS DIV.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc.
Wilkerson Corp.
Yarnall-Waring Co.

VALVE OPERATING MECHANISMS—does not include Controls.

Bristol Co.
Cash Co., A. W.
Cutler-Hammer, Inc.
Darling Valve & Mfg. Co.
DeZurik Corp.
Falcon Alarm Co., Inc.
Kieley & Mueller, Inc.
Ledeen, Inc.
Minneapolis-Honeywell Regulator Co.
Ohio Injector Co.
Okadee Co.
Philadelphia Gear Works
Republic Flow Meters Co.
Wilkerson Corp.

VENTILATION TUBING, NON-METALLIC—does not include Pipe, Ventilation

Acme Rubber Mfg. Co.
AMERICAN BRATTICE CLOTH CORP.
Bemis Bro. Bag Co.
DuPont de Nemours & Co., E. I.
DuPont de Nemours & Co., Inc. E. I. Explosives Dept.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div.
FLEXAUST CO.
Flexible Tubing Co.
Hamilton Rubber Mfg. Corp.
U. S. Rubber Co. Mechanical Goods Div.

VIBRATORS & VIBRATING MECHANISMS—also see: Car Shakers; Screen Eccentrics

Branford Co.
Cleveland Vibrator Co.
DIESEL ENERGY CORP.
Eriez Mfg. Co.
Hack Engineering Co.
HEWITT-ROBINS, INC.
Lecco Machinery & Engineering Co.
LINK-BELT CO. DEPT. EMJ-57
Lippmann Engineering Works, Inc.
Martin Engineering Co.
Syntron Co.
Tyler Co., W. S.
Universal Dredge Mfg. Co.

W

(WAGON DRILLS—see Drills)

(WAGONS—see: Truck Trailers; Cars, Mine)

(WASHERS, MINERAL (LOG, PUG ETC.)—see Scrubbers)

WASHING PLANTS, SAND & GRAVEL, COMPLETE, MOBILE & PORTABLE

BALDWIN-LIMA-HAMILTON CORP. CONSTRUCTIION EQUIPMENT DIV.
Bodinson Manufacturing Co., Inc.
Daniels Co. Contractors, Inc.
Davis Foundry & Machine Works
DENVER EQUIPMENT CO.
Diamond Iron Works Div. Goodman Mfg. Co.
EAGLE IRON WORKS
Fuel Process Co.
Heyl & Patterson, Inc.
IOWA MFG. CO.
Lippman Engineering Works, Inc.
McLanahan & Stone Corp.
Pioneer Engineering Div. Poor & Co. Inc.
Rogers Iron Works Co.
Smith Engineering Works
Universal Engineering Corp.
Washington Machinery Co.
WESTERN MACHINERY CO.
Yuba Manufacturing Co.

WATER CLARIFICATION & TREATMENT EQUIPMENT—also see Ion Exchange

ALLIS CHALMERS MFG. CO INDUSTRIES GROUP
American Water Softener Co.
American Well Works
BIRD MACHINE CO.
Brosites Products Corp.
BUILDERS-PROVIDENCE DIV. B-I-F INDUSTRIES
Chain Belt Co.
Christian Engineers, J. D.
Cochrane Corp.
Daniels Co. Contractors, Inc.
DENVER EQUIPMENT CO.
Dorr Oliver, Inc.
Enley Products, Inc.
Fisher & Porter Co.
Graver Water Conditioning Co.
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
HARDINGE CO., INC.
Infilco, Inc.
Ionics, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
LINK-BELT CO DEPT. EMJ-57
Mallinckrodt Chemical Works
Omega Machine Co., Div. B-I-F Industries
Permutit Co.
Taylor & Co., W. A.
WESTERN MACHINERY CO.
Zurn Mfg., J. A., Div. Zurn Industries, Inc.

WATER CLARIFICATION & TREATMENT CHEMICALS—does not include Ion Exchange Resins

ALLIS CHALMERS MFG CO. INDUSTRIES GROUP
American San-Banum Co., Inc.
Armour & Co.
Butler Bin Co.
Canadian Industries Ltd.
Cochrane Corp.
Dow Chemical Co.
DuPont de Nemours & Co., E. I.
Food Machinery & Chemical Corp. Westvaco Mineral Products Div. Westvaco Chlor-Alkali Div.
GENERAL CHEMICAL DIV. ALLIED CHEMICAL & DYE CORP. BAKER & ADAMSON PRODUCTS
Hagan Chemicals & Controls, Inc. Divisions: Calgon Co., Hall Laboratories
HERCULES POWDER CO.
Marathon Corp. Chemical Sales Dept.
Monsanto Chemical Co.
Pacific Lumber Co.
Pennsalt Chemicals Corp.
Permutit Co.
Pettinos, Inc., George F.
Philadelphia Quartz Co.
Stein, Hall & Co., Inc.
Union Carbide Chemicals Co. Union Carbide Corp.
Van Waters & Rogers, Inc.
West Virginia Pulp & Paper Co.
Wyandotte Chemicals Corp.
Zurn Mfg., J. A., Div. Zurn Industries, Inc.

(WEIGH HOPPERS—see Scales)

WELDING EQUIPMENT—does not include Metallizing Equipment

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
AMERICAN BRAKE SHOE CO. AMERICAN MANAGANESE STEEL DIV.
American Brake Shoe Co.
Caterpillar Tractor Co.
Daniels, Inc., C. R.
Eisler Engineering Co.
Gar Wood Industries, Inc.
General Electric Co. Ind. Haulage Div. -Loco. & Car Equip. Divs.
General Electric Co. Apparatus Sales Div.
HARNISCHFEGER CORP.
Hobart Bros. Co.
Industrial Air Products Co.
Kaiser Aluminum & Chemical Sales, Inc.
Kurz & Root Co.
Lincoln Electric Co.
Linde Co. Union Carbide Corp.
Marquette Mfg. Co., Inc.
Metal & Thermit Corp.
National Cylinder Gas Co.
Ohio Brass Co.
Parker Safety Equipment Co.
Phoenix Metal Products Co.
Sellstrom Mfg. Co.
Sight Feed Generator Co.
Smith Co., A. O.

Smith Welding Equipment Corp.
Tweco Products, Inc.
Universal Electric Sales Corp.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.
Wall Colmonoy Corp.
Westinghouse Electric Corp.
Worthington Corp.

WELDING RODS, ELECTRODES, SOLDER, ETC. ALSO SEE: Hard-facing; Metallizing Supplies

Air Reduction Sales Co., Div. Air Reduction Co., Inc.
All-State Welding Alloys Co., Inc.
Alloy Rods Co.
AMERICAN BRAKE SHOE CO. AMERICAN MANAGANESE STEEL DIV.
American Brass Co.
American Chain & Cable Co., Inc. Page Steel & Wire Div.
Ampco Metal, Inc.
Arcos Corp.
Coast Metals, Inc.
CRUCIBLE STEEL CO. OF AMERICA
Eisler Engineering Co.
Eutectic Welding Alloys Corp.
General Electric Co. Ind. Haulage Div. -Loco. & Car Equip. Divs.
General Electric Co. Apparatus Sales Div.
HARNISCHFEGER CORP.
Haynes Stellite Co. Div. Union Carbide Corp.
Hobart Bros. Co.
Industrial Air Products Co.
Industrial Overlay Metals, Inc.
International Nickel Co.
Lincoln Electric Co.
Linde Co. Union Carbide Corp.
Marquette Mfg. Co., Inc.
Metal & Thermit Corp.
Mueller Brass Co.
National Carbon Co. Div. Union Carbide Corp.
National Cylinder Gas Co.
Ohio Carbon Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Revere Copper & Brass, Inc.
Sight Feed Generator Co.
Smith Co., A. O.
Stackpole Carbon Co.
Stulz-Sickles Co.
Sylvania Electric Products, Inc.
Vanadium-Alloys Steel Co.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV.
Westinghouse Electric Corp.

WELDMENTS—also see: Bucket Teeth; Castings; Forgings; Tractor Wear-Replacement Parts

Alco Products, Inc.
AMERICAN BRAKE SHOE CO. AMERICAN MANAGANESE STEEL DIV.
American Brake Shoe Co.
Chattanooga Boiler & Tank Co.
Connellsville Mfg. & Mine Supply Co.
FALK CORP.
Farrell-Cheek Steel Co.
Graver Tank & Mfg. Co., Inc.
Industrial Air Products Co.
Industrial Overlay Metals, Inc.
Irwin Foundry & Mine Car Co.
Kirk & Blum Mfg. Co.
Lakeside Bridge & Steel Co.
Lukens Steel Co.
Mahon Co., R. C.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Meckum Engineering, Inc.
NATIONAL IRON CO.
Pollock Co., William B.
Sight Feed Generator Co.
Smith Co., A. O.
Sorel Steel Foundries, Ltd.
Wheeler Mfg. Co., C. H.

(WHEELS—see Car (& Locomotive) Wheels)

(WINCHES, WINDERS & HOISTS—see below; also see: Car Movers, Winch Types; Hoists)

WINCHES, AIR

American Hoist & Derrick Co.
Atlas Copco Eastern, Inc.
Atlas Copco Pacific, Inc.
CHICAGO PNEUMATIC TOOL CO.
Holman Bros.—Canada Ltd.
INGERSOLL-RAND CO.
JOY MFG. CO
Lidgerwood Industries, Inc.
Machinery Center Inc.
Silent Hoist & Crane Corp.

WINCHES, DIESEL & GASOLINE

American Hoist & Derrick Co.
CHICAGO PNEUMATIC TOOL CO.
Clyde Iron Works, Inc.
Gar Wood Industries, Inc.
INGERSOLL-RAND CO.
JOY MFG. CO.
Lidgerwood Industries, Inc.
O. K. Machinery Div. John C. Motter Printing Press Co.
Silent Hoist & Crane Corp.
Superior-Lidgerwood-Mundy Corp.

WINCHES, ELECTRIC

American Hoist & Derrick Co.
Christian Engineers, J. D.
Clyde Iron Works, Inc.
Easton Car & Construction Co.
Electro Lift, Inc.
Gar Wood Industries, Inc.
HARNISCHFEGER CORP.
INGERSOLL-RAND CO.
JOY MFG. O.
Lidgerwood Industries, Inc.
LINK-BELT CO. DEPT. EMJ-57
Machinery Center Inc.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
MOBILE BUMPER INC., DIV. MOBILE DRILLING INC.
MOBILE DRILLING, INC.
Moran Engineering Co.
O. K. Machinery Div. John C. Motter Printing Press Co.
Reading Crane & Hoist Corp.
Round & Sons, Inc., David
Sanford-Day Iron Works, Inc.
SAUERMAN BROS., Inc.
Shepard Niles Crane & Hoist Corp.
Silent Hoist & Crane Corp.
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.
Superior-Lidgerwood-Mundy Corp.
VULCAN IRON WORKS CO., (DENVER)
Washington Iron Works
Yuba Manufacturing Co.

WINCHES, HAND—does not include Hoists, Lift, Hand Chain

Bartlett & Snow Co., C. O.
Christian Engineers, J. D.
Griphoist, Inc.
Indiana Foundry Co.
LINK-BELT CO. DEPT. EMJ-57
Round & Son, Inc., David
Stephens-Adamson Mfg. Co.
Stimmel Winch Co., Inc.

WINCHES, HYDRAULIC

American Hoist & Derrick Co.
AUSTIN-WESTERN WORKS CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
Case Co., J. I. Industrial Div.
Lidgerwood Industries, Inc.
Manganese Steel Forge Co.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div.
Moran Engineering Co.
Mt. Sopris Instrument Co.
Silent Hoist & Crane Corp.
Star Wire Screen & Iron Works, Inc.
Superior-Ligerwood-Mundy Corp.
Vickers, Inc.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.

WIRE CLOTH

Buffalo Wire Works Co.
Cambridge Wire Cloth Co.
Chase Brass & Copper Co.
Colorado Fuel & Iron Corp.
HEWITT-ROBINS, Inc.
Hoyt Wire Cloth Co.
Korb-Pettit Wire Fabrics & Iron Works
Ludlow-Saylor Wire Cloth Co.
Multi-Metal Wire Cloth Co., Inc.
Newark Wire Cloth Co.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Pioneer Engineering Div. Poor & Co. Inc.
SIMPLICITY ENGINEERING CO.
Tyler Co., W. S.

(WIRE FENCING—see Fencing)

WIRE ROPE

American Chain & Cable Co. American Cable Div.
American Chain & Cable Co., Inc. Automotive & Aircraft Div.
American Chain & Cable Co. Hazard Wire Rope Div.
American Steel & Wire Div. U. S. Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Broderick & Bascom Rope Co.
Chase Brass & Copper Co.
Colorado Fuel & Iron Corp.
Electric Steel Foundry Co.
Hales Co., W. M.
JONES & LAUGHLIN STEEL CORP.
Leschen Wire Rope Div. H. K. Porter Company, Inc.
Macwhyte Co.
Pacific Wire Rope Co.
Paulsen-Webber Cordage Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rochester Ropes, Inc.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Ryerson & Son, Inc., Joseph T.
SAUERMAN BROS., INC
Tennessee Coal & Iron Div. U. S. Steel Corp.
Union Wire Rope Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
WESTINGHOUSE AIR BRAKE CO.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Wire Rope Corp. of America, Inc.
Yara Engineering Corp. Interstate Equipment Div.

(WIRE ROPE DRESSING—see Lubricants)

WIRE ROPE FITTINGS

American Chain & Cable Co. American Cable Div.
American Chain & Cable Co. Hazard Wire Rope Div.
American Hoist & Derrick Co.
American Steel & Wire Div. U. S. Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Colorado Fuel & Iron Corp.
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
Hales Co., W. M.
Hayes Steel Products, Ltd.
Interstate Drop Forge Co.
JONES & LAUGHLIN STEEL CORP.
Lamson & Sessions Co.
Leschen Wire Rope Div. H. K. Porter Company, Inc.
Macwhyte Co.
Madesco Tackle Block Co.
Pacific Wire Rope Co.
Page Engineering Co.
Paulsen-Webber Cordage Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Quay Industries
Rochester Ropes, Inc.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Ryerson & Son, Inc., Joseph T.
SAUERMAN BROS., INC.
Skookum Co., Inc.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Union Wire Rope Corp.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp.
Wire Rope Corp. of America, Inc.
Yara Engineering Corp. Interstate Equipment Div.

WIRE ROPE SLINGS

American Chain & Cable Co. American Cable Div.
American Chain & Cable Co. Hazard Wire Rope Div.
American Steel & Wire Div. U. S. Steel Corp.
Bethlehem Pacific Coast Steel Corp.
Bethlehem Steel Co., Inc.
Broderick & Bascom Rope Co.
Cambridge Wire Cloth Co.
Colorado Fuel & Iron Corp.
Electric Steel Foundry Co.
Hales Co., W. M.
JONES & LAUGHLIN STEEL CORP.
Leschen Wire Rope Div. H. K. Porter Company, Inc.
Macwhyte Co.
McMillan's Sons, W. H.
Pacific Wire Rope Co.
Paulsen-Webber Cordage Corp.
Pickard Industries, Inc. Central Mine Supply Co., Div.
Rochester Ropes, Inc.
Roebling's Sons Corp., John A. Subsidiary of Colorado Fuel & Iron Co.
Ryerson & Son, Inc., Joseph T.
Tennessee Coal & Iron Div. U. S. Steel Corp.
Union Wire Rope Corp.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV.
Wickwire Spencer Steel Div. Colrado Fuel & Iron Corp.
Wire Rope Corp. of America, Inc.

(WIRE SCREEN—see Screen)

2. Manufacturers' Index

Abbe' Engineering Co. 50 Church St. New York 7, N. Y.
Abrams Aerial Survey Corp. 606 Shiawassee St. Lansing, Mich.
Acker Drill Co. 725 West Lackawanna Ave. Scranton 3, Pa.
Ackerman-Johnson Co. 625 Jackson Blvd. Chicago 6, Ill.
Acme Electric Heating Co. 1217 Washington St. Boston 18, Mass.
Acme Machinery Co., P. O. Box 1169, Williamson, W. Va.
Acme Road Machinery Co., Inc. E. Main St. Frankfort, N. Y.
Acme Rubber Mfg. Co. State St. Trenton, N. J.
Acme Tank Mfg. Co. 12,000 E. Washington Whittier, Calif.
ADAMAS CARBIDE CO. 121 Market St. Kenelworth, N. J. Page 201
Advance Car Mover Co., Inc. Box 536 Appleton, Wis.
Aerofall Mills, Inc. 1025 W. Third Ave. Columbus 8, Ohio
Aeroquip Corp. 300 South East Ave. Jackson, Mich.
Aeroquip Corp., Western Div., 3015 Winona Ave. Burbank, Calif.
AERO SERVICE CORP., 210 East Courtland St. Philadelphia 20, Pa. Page 144
AERO SERVICE CORP. (MID-CONTINENT) 1401 South Detroit St. Tulsa, Okla. Page 144
AERO SERVICE CORP. (WESTERN) 500 Christie Bldg., Duluth, Minn. Page 144.
AERO SERVICE CORP. (WESTERN) 35 Richards St. Salt Lake City 10, Utah. Page 144.
Aetna Ball & Roller Bearing Co. Div. Parkersburg-Aetna Corp., 4600 Schubert Ave., Chicago 39, Il.
AFRICAN SURVEYS (PTY.), LTD., 44 Nugget St., Johannesburg, Union of South Africa. Page 144.
Ajax Flexible Coupling Co., Westfield., N. Y.
Ahlberg Bearing Co., 3025 W. 47th St., Chicago 32, Ill.
AINSWORTH & SONS, WILLIAM, 2151 Lawrence St., Denver 2, Colo. Page 234
Air Placement Equip. Co., 1005 West 24th St., Kansas City 8, Missouri
Air Reduction Sales Co., Div. Air Reduction Co., Inc., 150 East 42nd St., New York, N. Y.
Albany Felt Co., Albany 1, N. Y.
Alco Products, Inc., Schenectady 5, N. Y.
ALDON CO., 3338 Ravenswood Ave., Chicago, Ill. Page 245.
Aldrich Pump Co. 1 Pine St. Allentown, Pa.
Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pa.
Allen-Bradley Co., 1305 S. 1st St., Milwaukee 4, Wis.
Allen-Sherman-Hoff Co., 259 East Lancaster Ave., Wynnewood, Pa.
ALLEN-SHERMAN-HOFF PUMP CO., 259 E. Lancaster Ave., Wynnewood, Pa. Second Cover.
ALLIS CHALMERS MFG. CO., Buda Div., 1133 S. 70th St., Milwaukee 1, Wis. Opp. 118.
ALLIS CHALMERS MFG. CO., Industries Group, 969 South 70th St., Milwaukee 1, Wis. Opp. 118
ALLIS CHALMERS MFG. CO., CONSTRUCTION MACHY. DIV., 1126 South 70th St., Milwaukee, Wis. Opp. 118
Allis Co., Louis., 427 East Stewart St., Milwaukee 1, Wis.
Alloy Rods Co., York, Pa.
Alloy Steel & Metals Co., 1862 East 55th St. Los Angeles 58, Calif.
All-State Welding Alloys Co., Inc., 249-55 Ferris Ave., White Plains, N. Y.
Alpha Molykote Corp., 65 Harvard St., Stamford, Conn.
Alphaduct Wire & Cable Co., P. O. Box 709 New Brunswick, N. J.
Aluminum Co. of America., 1501 Alcoa Bldg., Pittsburgh 19, Pa.
American Air Filter Co., Inc., 215 Central Ave., Louisville 8, Ky.
American Air Surveys, Inc., 907 Penn Ave., Pittsburgh 22, Pa.
American Blower Div. American-Standard Detroit 32, Mich.
American Brake Shoe Co., 230 Park Ave., New York 17, N. Y.
AMERICAN BRAKE SHOE CO., AMERICAN MANGANESE STEEL DIV., 389 East 14th St., Chicago Heights, Ill. Opp. Page 148
American Brass Co., Waterbury 20, Conn.
AMERICAN BRATTICE CLOTH CORP., Warsaw, Ind. Page 232
American Car & Foundry Div., ACF Industries, Inc., 30 Church St., New York 7, N. Y.
American Chain & Cable Co., Inc., Page Steel & Wire Div., Monessen, Pa.
American Chain Div., American Chain & Cable Co., Inc., York, Pa.
American Chain & Cable Co., American Cable Div., Wilkes Barre, Pa.
American Chain & Cable Co., Inc., Automotive & Aircraft Div., 601 Stephenson Bldg., Detroit 2, Mich.
American Chain & Cable Co., Hazard Wire Rope Div., Wilkes-Barre, Pa.
American Chain & Cable Co., Inc., Helicoid Gage Div., Bridgeport 2, Conn.
American Chain & Cable Co., Inc., R-P & C Valve Div., Reading, Pa.
American Chain & Cable Co., Inc., Wright Hoist Div., York, Pa.
American Coldset Corp., U. S. Highway 46, Teterboro, N. J.
American Coleman Co., 301 South Nevada, Littleton, Colo.
American Conveyor Co., 2133 S. Christiana Ave., Chicago 13, Ill.
American Crucible Products Co., 1305 Oberlin Ave., Lorain, Ohio.
AMERICAN CYANAMID CO., EXPLOSIVES DEPT., 30 Rockefeller Plaza, New York 20, N. Y. Page 157
AMERICAN CYANAMID CO., MINING CHEMICALS DEPT., 30 Rockefeller Plaza, New York 20, N. Y. Page 157
American Emery Wheel Works, Richmond Square Providence 1, R. I.
American Flexible Coupling Div., Zurn Industries, Inc., Pittsburgh Ave., Erie, Pa.
American Forge Co., Niles, Calif.
American Hard Rubber Co., 93 Worth St., New York 13, N. Y.
American Hoist & Derrick Co., 63 S. Robert St., St. Paul, Minn.
American Instrument Co., Inc., 8030 Georgia Ave., Silver Spring, Md.
American Machine & Metals, Inc., De Bothezat Fan Div., East Moline, Ill.
American-Marsh Pumps, Inc., 60 Capital Ave., Battle Creek, Mich.
AMERICAN METAL CO., 61 Broadway, New York, N. Y. Page 244
AMERICAN MINE DOOR CO., 2039 Duber Ave., S.W. Canton 6, Ohio. Page 207
American Oil Co., 555 Fifth Ave., New York 17, N. Y.
American Optical Co., 14 Mechanic St., Southbridge, Mass.
American Paulin System, 1524 South Flower St., Los Angeles 15, Calif.
American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.
American Pulverizer Co., 1275 Macklin Ave., St. Louis 10, Mo.
American Rectifier Co., 95 Lafayette St., New York, N. Y.
American Rubber Mfg. Co., 1145 Park Ave., Oakland 8, Calif.
American Sand-Banum Co., Inc., Meadow Brook National Bank Bldg., Freeport, N. Y.
AMERICAN SMELTING & REFINING CO., 120 Broadway, New York 14, N. Y. Page 248
AMERICAN SMELTING & REFINING CO., Federated Metals Div., 120 Broadway, New York 5, N. Y. Page 248
American Spectrographic Laboratories, Inc., 557 Minna St., San Francisco, Calif.
American Steel Foundries., Prudential Plaza, Chicago 1, Ill.
American Steel & Wire Div., U. S. Steel Corp., Rockefeller Bldg., Cleveland, Ohio.
American Tractor Equipment Corp., 9131 San Leandro Blvd., Oakland 3, Calif.
American Water Softener Co., Lehigh Ave. & Fourth St., Philadelphia 33, Pa.
American Well Works, 180 N. Broadway, Aurora, Ill.
Ames Co., O. Parkersburgh, W. Va.
Ames Iron Works, Inc., 25 E. 2nd St. Oswego, N. Y.
Ammann Photogrammetric Engineers Inc., Jack., Broadway at Tenth, San Antonio, Tex.
Ampco Metal, Inc., 1739 South 38th St., Milwaukee 46, Wis.
ANACONDA WIRE & CABLE CO., 25 Broadway, New York 4, N. Y. Page 239
Analytical Measurements, Inc., 585 Main St., Chatham, N. J.
Anchor Plastics Co. Inc., 36-36 36th St., Long Island City 6, N. Y.
Anderson Mfg. Co., Albert & J. M., 289 A St., Boston 10, Mass.
Ansonia Wire & Cable Co., 111 Martin St., Ashton, R. I.
Anthony Co.
Apache Powder Co., Bonson, Ariz.
Appleton Electric Co., 1701 Wellington Ave., Chicago 13, Ill.
Arcos Corp., 1500 S. 50th St., Philadelphia 43, Pa.
Arizona Assay Office, 815 N. 1st St., Phoenix, Ariz.
Arizona Testing Laboratories, 817 W. Madison St., Phoenix, Ariz.
Arkansas Fuel Oil Corp., Slattery Bldg. Shreveport 4, La.
Armco Drainage & Metal Products, Inc., 703 Curtis St., Middletown, Ohio.
Armor Electric Mfg. Co., 1020 Holland St., Erie, Pa.
Armour & Co., 1355 West 31st St., Chicago 9, Ill.
Armstrong, Bray & Co., 5364 Northwest Hwy., Chicago 30, Ill.
Armstrong Rubber Co., West Haven, Conn.
AROS ELECTRIC, INC., 500 Fifth Ave., New York 36, N. Y. Page 181
Arrow Mfg. Co., P. O. Box 4120 South Denver Station, Denver 9, Colo.
Arrow Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford 6, Conn.
Arrow Tank Co., 16 Barnett St., Buffalo 15, N. Y.
Arrowhead Products Div. Federal-Mogul-Bower, Bearings Inc., 2300 Curry St., Long Beach 5, Calif.
Arrowhead Steel Buildings, Inc., 1122 W. Railroad St., Duluth 2, Minn.
Asbestos Mfg. Co., Huntington, Inc.
Assembly Products, Inc., Wilson Mills Rd., Chesterland 70, Ohio.
ASSOCIATED METALS & MINERALS CORP., 75 West St., New York 6, N. Y. Page 235
Ateco Div. Greenville Steel Car Co., Greenville, Pa.
ATHEY PRODUCTS CORP., 5631 West 65th St., Chicago 38, Ill. Page 199
Atlantic Refining Co., 260 S. Broad St., Philadelphia, Pa.
Atlantic Tank Corp., 1207 Tonnelle Ave., North Bergen, N. J.
Atlas Car & Mfg. Co., 1140 Ivanhoe Rd., Cleveland 10, Ohio.
Atlas Chain & Mfg. Co., P. O. Box 708, West Pittston, Pa.
Atlas Conveyor Co., Clintonville, Wis.
Atlas Copco Eastern, Inc., 151 Linwood Ave., Paterson 25, N. J.
Atlas Copco Pacific, Inc., 930 Brittan Ave., San Carlos, Calif.
ATLAS POWDER CO., Concord Pike & Murphy Rd., Wilmington, Del. Page 233.
Atlas Steel Casting Co., 1963 Elmwood Ave., Buffalo 7, N. Y.
Atlas Steels, Ltd., Welland, Ontario, Canada.
AUSTIN-WESTERN WORKS CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP., Aurora, Ill. Page 187
Auto-Lite Battery Corp., Toledo 1, Ohio.
Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill.
Automatic Switch Co., Hanover Rd., Florham Park, N. J.

BABCOCK & WILCOX CO., 161 East 42nd St., New York 6, N. Y. Page 146.
Bacon-Greene & Milroy, 29 Washington Ave., P. O. Box 4343, Hamden, Conn.
Badger Malleable & Mfg. Co., South Milwaukee, Wis.
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.
Baker & Co., Inc., 113 Astor St., Newark, N. J.
Baker Chemical Co., J. T., Phillipsburg, N. J.
Baker-Raulang Co., 1250 West 80th St., Cleveland 2, Ohio.
Balderson Inc., Wamego, Kan.
Baldor Electric Co., 4351-67 Duncan Ave., St. Louis 10, Mo.
BALDWIN-LIMA-HAMILTON CORP. Construction Equipment Div., South Main St., Lima, Ohio. Page 187
BALDWIN-LIMA-HAMILTON CORP., Standard Steel Works Div., Burnham, Pa. Page 187
Band-It Co., 48th & Dahlia, Denver 16, Colo.
BARBER-GREENE CO., 400 North Highland Ave., Aurora, Ill. Page 188
Barnes Mfg. Co., 615 North Main St., Mansfield, Ohio.
Barrett Haentjens & Co., Hazelton, Pa.
Bartlett & Snow Co., C. O., 6200 Harvard Ave., Cleveland 5, Ohio
Bates Co., Walter, 500 Mills Rd., Joliet, Ill.
Bausch & Lomb Optical Co., 837 St. Paul St., Rochester 2, N. Y.
Baxter & Co., J. H., 120 Montgomery St., San Francisco 4, Calif.
Bay City Shovels, Inc., Bay City, Mich.
Bay State Abrasive Products Co., 12 Union St., Westboro, Mass.
Beach-Russ Co., 50 Church St., New York 7, N. Y.
Beall Pipe & Tank Corp., 12005 N. Burgard St., Portland 3, Ore.
Beckman Instruments, Inc., Berkeley Div., 2200 Wright Ave., Richmond, Calif.
Beckman Instruments, Inc., Process Instruments Div., 250 Fullerton Rd., Fullerton, Calif.
Beech Aircraft Corp., 6600 East Central St., Wichita, Kan.
Bell Helicopter Corp., P. O. Box 482 Fort Worth 1, Tex.
Belle City Malleable Iron Co., Racine Steel Castings Co., 1442 Forest St., Racine, Wis.
Belmont Packing & Rubber Co., Butler & Sepviva St., Philadelphia 37, Pa.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn 7, N. Y.
Bemis Bro. Bag Co., 408 E. Pine St., St. Louis 2, Mo.
Benton Harbor Engineering Works, Inc., 622 Langley, St. Joseph, Mich.
Berger & Sons, C. L., Inc., 37 Williams St., Roxbury 19, Mass.
Beryllium Corp., Tuckerton Rd., Reading, Pa.
Bete Fog Nozzle, Inc., 309 Wells St., Greenfield, Mass.
Bethlehem Foundry & Machine Co., W. 2nd St., Bethlehem, Pa.
Bethlehem Pacific Coast Steel Corp., 20th & Illinois Sts., San Francisco, Calif.
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Bico, Inc., 3116 Valhalla Dr., Burbank, Calif.
Bigelow-Liptak Corp., 13300 Puritan Ave., Detroit 27, Mich.
BIN-DICATOR CO., 13946 Kercheval St., Detroit 15, Mich. Page 187
Binks Mfg. Co., 3114 Carroll Ave., Chicago 12, Ill.
BIRD MACHINE CO., South Walpole, Mass. Page 251
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Bitco, Inc., P. O. Box 929, Wallace, Idaho.
BIXBY-ZIMMER ENGR. CO., 961 Abingdon St., Galesburg, Ill. Page 222
Black & Decker Mfg. Co., 600 East Pennsylvania Ave., Towson, Md.
Black, Sivalls & Bryson, Inc., 7500 East 12th St., Kansas City 26, Mo.
Black Diamond Spad Co., 2108 Stratford Rd., Richmond 25, Va.
Blackhawk Mfg. Co., 5325 West Rogers Milwaukee 46, Wis.
Black's Machine Shop, 169 East Willow St., Bishop, Calif.
BLAW-KNOX CO., Blaw-Knox Bldg. 300 Sixth Ave., Pittsburgh 22, Pa. Page 220
BLAW-KNOX CO., Power Piping & Sprinkler Div., 829 Beaver Ave., Pittsburgh, Pa. Page 220.
Blount Co., J. G., Woodland St., Everett 49, Mass.
Blue M Electric Co., 138 & Chatham St., Blue Island, Ill.
Bodinson Manufacturing Co., Inc., 2401 Bayshore Blvd., San Francisco, Calif.
Boland Development Co. Ltd., 155 Chadbourne Ave., Noranda, Quebec, Canada.
BOLTON FARM PACKING CO., INC., 176 Oak St., Newton 64, Mass. Page 230.
Bonded Scale & Machine Co., 38 Bellview, Columbus 7, Ohio.
BOOTH CO., 333 West 14 South St., Salt Lake City 4, Utah. Page 234.
Borden Metal Products Co., Elizabeth, N. J.
Borne Scrymser Co., 632 S. Front St., Elizabeth, N. J.
Boston Woven Hose & Rubber Co., Boston 3, Mass.
Bower Roller Bearing Div. Federal-Mogul-Bower Bearings, Inc., 5040 Hart Ave., Detroit 14, Mich.
Bowers Battery & Spark Plug Co., Box 1262, Reading, Pa.
BOYLES BROS. DRILLING CO. (UTAH), 1321 South Main St., Salt Lake City, Utah. Page 169.
BOYLES BROS. DRILLING CO. LTD. (VANCOUVER)., 1275-1291 Parker St., Vancouver 6, Canada. Page 217.
Brabender Corp., Rochelle Park, N. J.
Brad Foote Gear Works, Pittsburgh Gear Co. Div., Neville Island, Pittsburgh 25, Pa.
Bradley Pulverizer Co., 123 So. 3rd St., Allentown, Pa.
Brady Co., W. H., 727 Glendale Ave., Milwaukee 9, Wis.
Brammer Corp., 684 Broadway, New York 12, N. Y.
Branford Co., 131 Chestnut St., New Haven, Conn.
Brass Foundry Co., 713 S. Adams St., Peoria 2, Ill.
Bridgeport Brass Co., 30 Grand St., Bridgeport, Conn.
Bridgeport Chain & Mfg. Co., 962 Crescent Ave., Bridgeport 1, Conn.
Briggs & Stratton Corp., 2711 North Thirteenth St., Milwaukee 1, Wis.
Bright Star Industries, 600 Getty Ave., Clifton, N. J.
Bristol Co., P. O. Box 1790 EMJ, Waterbury 20, Conn.
Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.
Brooks Oil Co., 982 Ridge Ave., Pittsburgh 12, Pa.
BROOKVILLE LOCOMOTIVE WORKS, Steele Blvd., Brookville, Pa. Page 250.
Brosites Products Corp., 50 Church St., New York, N. Y.

Brown, Inc., David, 999 Beecher St., San Leandro, Calif.
Browning Mfg. Co., Maysville, Ky.
Bruning Co., Inc. Charles, 4702 Montrose Ave., Chicago 41, Ill.
BRUNNER & LAY ROCK BIT OF PHILADELPHIA, INC., 2516 E. Cumberland St., Philadelphia 25, Pa. Page 252.
Brunson Instrument Co., 1405 Walnut St., Kansas City 6, Mo.
Bucyrus-Erie Co., South Milwaukee, Wis.
BUELL ENGINEERING CO., 70 Pine St., New York 5, N. Y. Page 249.
Buffalo Forge Co., 490 Broadway, Buffalo 5, N. Y.
Buffalo Hammer Mill Corp., 1238 McKinley Pkwy., P. O. Box 3, Buffalo 18, N. Y.
Buffalo Scale Co., Inc., 46 Letchworth St., Buffalo 13, N. Y.
Buffalo Wire Works Co., 308 Terrace St., Buffalo 2, N. Y.
BUILDERS-PROVIDENCE DIV., B-I-F Industries, 345 Harris Ave., Providence, R. I. Page 232.
Bullard Co., E. D., 2680 Bridgeway., Sausalito, Calif.
BullDog Electric Products Co., Detroit 32, Mich.
Bunting Brass & Bronze Co., 715 Spencer St., Toledo 1, Ohio.
Burgess Battery Co., Freeport, Ill.
Burndy Corp., Post Rd., Norwalk, Conn.
Burton Equipment Co., Inc., 4810 Firestone Blvd., South Gate, Calif.
Butler Bin Co., 993 Blackstone Ave., Waukesha, Wis.
Butler Manufacturing Co., 7400 East 13th St., Kansas City, Mo.
Byers Co., A. M., Clark Bldg., Pittsburgh 22, Pa.
Byron Jackson Div., Borg-Warner Corp., P. O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

C—A Wood Preserver Co., 3622 Dover Pl., St. Louis 16, Mo.
C & D Batteries, Inc., Conshohocken, Pa.
C & D Div. Yuba Manufacturing Co., 701 East "H" St., Benicia, Calif.
Cabot, Inc., Samuel, 141 Milk St., Boston 9, Mass.
Cadillac Malleable Iron Co., Cadillac, Mich.
Cadman Mfg. Co., A. W., 2816 Smallman St., Pittsburgh 22, Pa.
Calabrian Co. Inc., 141 Broadway, New York 4, N. Y.
Caldwell Co., W. E., 2540 Brooks St., Louisville 8, Ky.
California Testing Laboratories, Inc., 619 E. Washington Blvd., Los Angeles 15, Calif.
Calumet Div. Calumet & Hecla, Inc., Calumet, Mich.
Cambridge Wire Cloth Co., 152 Linkwood Rd., Cambridge, Md.
CANADIAN AERO SERVICE LTD., 348 Queen St., Ottawa, Ontario, Canada. Page 144.
Canadian Industries Ltd., P. O. Box 10, Montreal, Canada.
Canadian Locomotive Co., Ltd., Kingston Ontario, Canada.
Carboline Co., 331 Thornton Ave., St. Louis 19, Mo.
Carbolineum Wood Preserving Co., 526 W. Highland Ave., Milwaukee 3, Wis.
Carbon Engineering Corp., P. O. Box 236, Slinger, Wis.
Carbone Corp., 400 Myrtle Ave., Boonton, N. J.
CARD IRON WORKS, C. S., 2501 West 16th Ave., Denver 4, Colo. Page 226.
Cardox Corp., Hardsocg Div., 307 N. Michigan Ave., Chicago 1, Ill.
Carey Mfg. Co., Philip, Lockland, Cincinnati 15, Ohio.
Cargille Laboratories, Inc., R. P., 117 Liberty St., New York 6, N. Y.
Carlon Products Corp., 10225 Meech Ave., Cleveland, Ohio.
Carlyle Rubber Co., 103-107 Warren St., New York, N. Y.
CARPCO MANUFACTURING, INC., 4120 Haines St., Jacksonville, Fla. Third Cover.
Carpenter Steel Co., 115 W. Bern St., Reading, Pa.
Carrier Conveyor Corp., 211 North Jackson, Louisville 2, Ky.
Carrier Corp., 300 South Geddes St., Syracuse 1, N. Y.
Carver Pump Co., Muscatine, Iowa.
Case Co., J. I. Industrial Div., 700 State St., Racine, Wis.
Cash Co., A. W., P. O. Box 551 Decatur, Ill.
Catalytic Construction Co., 1528 Walnut St., Philadelphia 2, Pa.
Caterpillar Tractor Co., Peoria, Ill.
Cement Gun Co., 1520 Walnut St., Allentown, Pa.
Central Mine Equipment Co., 6200 North Broadway, St. Louis 15, Mo.
Central Scientific Co., 1700 Irving Park Road., Chicago 13, Ill.
Centric Clutch Co., P. O. Box 175, Woodbridge, N. J.
Centrifugal & Mech. Industries, Inc., 146 President St., St. Louis 18, Mo.
Century Electric Co., 1806 Pine St., St. Louis 3, Mo.
Cessna Aircraft Co., 5800 Franklin Rd., Wichita, Kan.
Chain Belt Co., 4679 West Greenfield Ave., Milwaukee 1, Wis.
Chain Belt Co. Shafer Bearing Div., 801 Burlington, Downers Grove, Ill.
Chapman & Wood, 536 Jefferson St., N. E. P. O. Box 8302., Albuquerque, N. M.
Charcoal Corp. of America, 726 Fairmont Ave., Fairmont, W. Va.
Charlton Laboratories., 2340 S. W. Jefferson St., Portland 7, Ore.
Chase Bag Co., 309 W. Jackson Blvd., Chicago 6, Ill.
Chase Brass & Copper Co., 236 Grand St., Waterbury 91, Conn.
Chatillon & Sons, John, 85 Cliff St., New York 38, N. Y.
Chattancoga Boiler & Tank Co., 1036 E. Main St., Chattanooga 1, Tenn.
CHEATHAM ELECTRIC SWITCHING DEVICE CO., 4780 Crittenden Drive, Louisville 9, Ky. Page 250.
Chelsea Fan & Blower Co., 639 South Ave., Plainfield, N. J.
Chemical Construction Corp., 525 West 43rd St., New York, N. Y.
Chemical & Power Products, Inc., 11 Broadway, New York 4, N. Y.
Chemical Process Co., P. O. Box 829, Redwood City, Calif.
Chester Cable Corp., 521 Fifth Ave., Chester, N. Y.
Chester Hoist Div. National Screw Mfg. Co., Lisbon, Ohio.
Chicago Belting Div. Chicago-Allis Mfg. Corp., 113 N. Green St., Chicago 7, Ill.
Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago 4, Ill.
Chicago Expansion Bolt Co., 1338 W. Concord Pl., Chicago 22, Ill.
Chicago Eye Shield Co., 2304 Warren Blvd., Chicago, Ill
Chicago Perforating Co., 2445 24th Pl., Chicago 8, Ill.
CHICAGO PNEUMATIC TOOL CO., 6 East 44th St., New York 17, N. Y. Page 154.
Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago 7, Ill.
Chiksan Co., 330 North Pomona Ave., Brea, Calif.
Chisholm-Moore Hoist Div. Columbus McKinnon Chain Corp., 5045 Fremont Ave., Tonawanda, N. Y.
CHRISTENSEN DIAMOND PRODUCTS CO., 1937 South 2nd West St., Salt Lake City 10, Utah. Page 158.
Christian Engineers, J. D., 480 Potrero Ave., San Francisco 10, Calif.
Chrysler Corp., Dodge Truck Div. 7900 Joseph Campau Ave., Detroit, Mich.
Cincinnati Electrical Tool Co., 304 Mt. Hope Ave., Cincinnati 4, Ohio.
Cincinnati Mine Mach'y Co., 2980 Spring Grove Ave., Cincinnati 25, Ohio.
Cincinnati Rubber Mfg. Co. Div. Thor Power Tool Co., Cincinnati 12, Ohio.
Circle F Mfg. Co., 720 Monmouth St., Trenton 4, N. J.
Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth, N. Y.
Cities Service Oil Co., 54 Wall St., New York 5, N. Y.
Clarage Fan Co., 619 Porter St., Kalamazoo 16, Mich.
Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.
Clark Equipment Co., Construction Machinery Div., Box 599 Pipestone Rd., Benton Harbor, Mich.
Clark Equipment Co., Transmission Div. Jackson 1, Mich.
Clarkson Co., 564 Market St., San Francisco 4, Calif.
Cleveland Crane & Engrg. Co., 5866 E. 289 St., Wickliffe, Ohio.
Cleveland Electric Motor Co., 5213 Chester Ave., Cleveland 3, Ohio.
Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland 13, Ohio.
Cleveland Worm & Gear Co., 3249 East 80th St., Cleveland 4, Ohio.
Climax Engine & Pump Mfg. Co., 208 South LaSalle St., Chicago 4, Ill.
Climax Molybdenum Co., 500 Fifth Ave., New York, N. Y.
Cline Truck Co., 3501 Gardner Ave., Kansas City 20, Mo.
Cling-Surface Co., 1032 Niagara St., Buffalo 13, N. Y.
Clipper Belt Lacer Co., 974 Front St., N. W. Grand Rapids 2, Mich.
Clipper Mfg. Co., 2800 Warwick St., Kansas City 8, Mo.
Clyde Iron Works, Inc., 29th Ave. West & Michigan St., Duluth, Minn.
Coast Mfg. & Supply Co., Box 71, Livermore, Calif.
Coast Metals, Inc., Redneck Ave., Little Ferry, N. J.
Coates Steel Products Co., Greenville, Ill.
Cochrane Corp., 17th and Alleghany, Philadelphia, Pa.
Coeur d'Alene Hardware & Foundry Co., Wallace, Idaho.
Coffing Hoist Div. Duff-Norton Co., 800 Walter St., Danville, Ill.
Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R. I.
Colorado Fuel & Iron Corp., Continental Oil Bldg, Denver 2, Colo.
COLORADO IRON WORKS CO., A Subsidiary of Mine & Smelter Supply Co., 3800 Race St., P. O. Box 9041, Denver 16, Colo. Page 237.
Columbia Electric Mfg. Co., 4519 Hamilton Ave., N. E. Cleveland 14, Ohio.
Columbian Steel Tank Co., 1509 West 12th St., Kansas City 1, Mo.
Columbus Conveyor Co., 869 W. Goodale Blvd., Columbus 8, Ohio.
Columbus Forge & Iron Co., 544 W. First Ave., Columbus 8, Ohio.
Combustion Engineering Inc., 200 Madison Ave., New York 16, N. Y.
Combustion Engineering, Inc., Raymond Div. 1323 N. Branch St., Chicago 22, Ill.
Commercial Shearing & Stamping Co. Dept. EMJ-MG, 1775 Logan Ave., Youngstown, Ohio.
Commercial Solvent Corp., 260 Madison Ave., New York 16, N. Y.
Commercial Testing & Engrg. Co., 228 North LaSalle St., Room 924, Chicago 1, Ill.
Compton, Inc., P. O. Box 1946, Clarksburg, W. Va.
Conco Engineering Works, Mendota, Ill.
Concordia Electric Co., 1521 Saw Mill Run Blvd., Pittsburgh 10, Pa.
Condenser Service & Engineering Co., 150 Observer Highway, Hoboken, N.J.
Cone-Drive Gears Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.
Conley Frog & Switch Co, Bodley Ave P. O. Box 3188, Memphis 9 Tenn.
Connellsville Mfg. & Mine Supply Co, Connellsville, Pa.
Conrader Co., Inc. R, 236 17th St., Erie, Pa.
Consolidated Electrodynamics Corp, 300 N Sierra Madre Villa, Pasadena, Calif.
Consolidated Packaging Machinery Corp, 1400 West Ave., Buffalo 13, N. Y.
Construction Machy Co., Box 120, Waterloo Iowa.
Continental-Diamond Fibre Corp., A Subsidiary of Budd Co, Newark Del.
Continental Electric Co. Inc., 325 Ferry St., Newark 5, N. J.
Continental Gin Co. Industrial Div., P. O. Box 2614, Birmingham 2, Ala.
Continental Mineral Processing Co, First National Bank Bldg., Cincinnati 2, Ohio.
Continental Motors Co., Muskegon, Mich.
Continental Ore Corp., 500 5th Ave., New York 36, N Y.
Continental Rubber Works, 1939 Liberty St., Erie, Pa.
Control Corp, 718 Central Ave, Minneapolis 14, Minn.
Convair Inc., Box 9671, Pittsburgh 26, Pa.
Conveyor Systems Inc, 325 S California Ave., Chicago, Ill.
Cooper-Bessemer Corp., Mt. Vernon, Ohio.
Coors Porcelain Co, 600 NInth St, Golden, Colo.
Coover Railroad Track Brace Co, P O Box 254, Dayton 1, Ohio.
Copperweld Steel Co., 9th St. & Allegheny Ave, Glassport Pa.
COPPUS ENGINEERING CO, 344 Park Ave., Worcester 2, Mass. Page 185.
Corhart Refractories Co, 16th & Lee Sts., Louisville 10, Ky.
Corning Glass Works, Corning, N. Y.
Crane Co., 836 South Michigan Ave., Chicago 5, Ill.
Crane Puller Co., Waltham 54, Mass.
Crescent Belt Fastener Co., Inc., 480 Lexington Ave., New York, N. Y.
Crescent Insulated Wire & Cable Co., Olden & Taylor Aves., Trenton 5, N. J.
Crosby Valve & Gage Co., 43 Kendrick St., Wrentham, Mass.
Crouse Hinds Co., Wolf & Seventh North Sts., Syracuse 1, N. Y.
CRUCIBLE STEEL CO. OF AMERICA, Oliver Bldg., Mellon Square, Pittsburgh 22, Pa. Page 190.
Cullman Wheel Co., 1344 W. Altgeld St., Chicago 14, Ill.
Cummings Jr. & Associates, Robt. A., 300 Sixth Ave., Pittsburgh 22, Pa.
Cummins Engine Co. Inc., Fifth & Union Sts., Columbus, Ind.
Curtis Manufacturing Co., 1905 Kienlen Ave., St. Louis 20, Mo.
Curtiss-Wright Corp., Electronics Div., 631 Central Ave., Carlstadt, N. J.
Custom Assay Office, Box 811, El Paso, Tex.
Cutler-Hammer Inc., 237 N. 12th St., Milwaukee 1, Wis.

Dagley Mfg. Co., 1217 East Sixth St., Joplin, Mo.
Daniels Co. Contractors Inc., 26 North Fifth St., Indiana, Pa.
Daniels Inc., C. R., Daniels, Md.
Darling Valve & Mfg. Co., Foot of Walnut St., Williamsport, Pa.
Darworth Inc., Cuprinol Div., Simsbury, Conn.
DART TRUCK CO., 2621 Oak St., Kansas City, Mo. Page 215.
Davey Compressor Co., Kent, Ohio.
Davidson Co. MT, 7 Dey St., New York 7, N. Y.
Davis Foundry & Machine Works, Old Furnace Road, Rome, Ga.
Dean Hill Pump Co., 4000 E. 16th St., Indianapolis 7, Ind.
Deason & Nichols, 160 South West Temple St., Salt Lake City 8, Utah.
Diester Concentrator Co., 901 Glasgow Ave., Fort Wayne 1, Ind.
Diester Machine Co., 1933 East Fort Wayne St., Fort Wayne 4, Ind.
DeLaval Steam Turbine Co., 855 Nottingham Way, Trenton 2, N. J.
DeLong Engineering Corp., 29 Broadway, New Yerk 6, N. Y.
Delta-Star Electric Div., H. K. Porter Company Inc., 2437 Fulton St., Chicago 12, Ill.
Deltron Electric Products Inc., Ebensburg, Pa.
Deming Co., 42 Broadway, Salem, Ohio.
Denver Equipment Co., P. O. Box 5268, Denver 17, Colo.
Denver Fire Clay Co., 2301 Blake St., P. O. Box 5510, Denver, Colo.
DeSousa Co., Inc., J. E., 217 Broadway, New York 7, N. Y.
Detectron Corp., 5528 Vineland Ave., North Hollywood, Calif.
Detroit Diesel Engine Div. General Motors Corp., 13400 W. Outer Dr., Detroit 28, Mich.
Detroit Hoist & Machine Co., 8224 Morrow St., Detroit 11, Mich.
Dewey & Almy Chemical Co., Div., W. R. Grace & Co., 62 Whittemore Ave., Cambridge, Mass.
DeZurik Corp., Sarteil, Minn.
Diamond Chain Co., Inc., 452 Kentucky Ave., Indianapolis 7, Ind.
Diamond Drill Carbon Co., 244 Madison Ave., New York 16, N. Y.
DIAMOND DRILL CONTRACTING CO., Station B-Box 4065 South 18 Stone St., Spokane 15, Wash. Page 250.
Diamond Iron Works Div. Goodman Mfg. Co., Halsted St. & 48th Pl., Chicago 9, Ill.
Diamond Power Specialty Corp., Lancaster, Ohio.
Diamond Products, Inc., 336 Prospect Ave., Elyria, Ohio.
DIAMOND TOOL RESEARCH CO., INC., 380 Second Ave., New York 10, N. Y. Page 242.
Dick Co., R. & J., Sade St., Passaic, N. J.
Dicke Tool Co., 1201 Warren Ave., Downers Grove, Ill.
Dickinson Laboratories, Inc., 1300 W. Main St., El Paso, Tex.
Diehl Mfg. Co., 1199 Findrene Ave., Somerville, N. J.
DIESEL ENERGY CORP., 82 Beaver St., New York, N. Y. Page 225.
Dietz Co., Henry G. Coral Designs Div., 12-16 Astoria Blvd., Long Island City 2, N. Y.
Differential Steel Car Co., Findlay, Ohio.
DINGS MAGNETIC SEPARATOR CO., 4740 West Electrical Ave., Milwaukee 46, Wis. Page 219.
Dixon Crucible Co., Joseph, Monmouth & Wayne St., Jersey City 3, N. J.
Dixon Valve & Coupling Co., Philadelphia 22, Pa.
Dodge Mfg. Corp., South Union St., Mishawaka, Ind.
Dominion Steel & Coal Corp., Ltd., Canada Cement Bldg., Montreal, Quebec, Canada.
Dorr Oliver, Inc., Barry Place, Stamford, Conn.
Douety Mining Equipment Ltd., Ashchurch, Gloucester, England.
Dow Chemical Co., Hopkins Bldg., Midland, Mich.
Dow Corning Corp., Midland, Mich.
DRAVO CORP., Neville Island, Pittsburgh 25, Pa. Page 192.
Dresser-Ideco Co., 975 Michigan Ave., Columbus 8, Ohio.
Dresser Mfg. Div. Dresser Industries, Inc., Bradford, Pa.
Drilling Accessory & Mfg. Co., Inc., 2006 S. Industrial, Dallas, Tex.
Drott Mfg. Co., 3841 West Wisconsin Ave., Milwaukee 8, Wis.
Ducon, Inc., 153 East Second St., Mineola, N. Y.
Duff Norton Co., 2709 Preble Ave., Pittsburgh 30, Pa.
DuPont de Nemours & Co., E. I., Wilmington, Del.

DuPont de Nemours & Co., Inc. E. I. Explosives Dept., 2343 Nemours Bldg., Wilmington 98, Del.
DuPont de Nemours & Co., Inc. E. I. Fabrics Div., Fairfield 6, Conn.
Duquesne Mine Supply Co., Pittsburgh 9, Pa.
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
Duriron Co., Inc., 450 North Findlay St., Dayton 1, Ohio.
Dustex Corp., Box 2520, 1758 Walden Ave., Buffalo 25, N. Y.
Dwight-Lloyd Div. McDowell Co., Inc., 16300 Waterloo Rd., Cleveland 10, Ohio.

EAGLE IRON WORKS, P. O. Box 934, Des Moines 4, Iowa. Page 240.
Eagle-Picher Co., American Bldg., Cincinnati 1, Ohio.
Eastern Electro-Casting Co., Ltd., 1980 Sherbrooke St., W., Montreal, Que., Canada.
Eastman Mfg. Co., 1440 N. 24th St., Manitowoc, Wis.
Eastman-Pacific Co., 2320 East Eighth St., Los Angeles 21, Calif.
Easton Car & Construction Co., Easton, Pa.
Eaton Mfg. Co., 739 E. 140th St., Cleveland 10, Ohio.
Edison, Inc., T. A. Edison Storage Battery Div., Lakeside Ave., West Orange, N. J.
Edward Valves, Inc., 1200 W. 145th St., East Chicago, Ind.
EIMCO CORP., 634 South Fourth West St., Box 300, Salt Lake City 10, Utah. Opp. 154.
Eisler Engineering Co., 740 S. 13th St., Newark 3, N. J.
El Paso Testing Laboratories, El Paso, Tex.
El-Tronics, Inc., 1360 Sub. Sta. Build., Philadelphia 3, Pa.
Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J.
Electric Controller & Mfg. Co. Div. Square D. Co., 4500 Lee Rd., Cleveland 28, Ohio.
Electric Machinery Mfg. Co., 800 Central Ave., Minneapolis 13, Minn.
Electric Materials Co., North East, Pa.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electric Steel Foundry Co., 2141 North West 25th Ave., Portland 10, Ore.
ELECTRIC STORAGE BATTERY CO. EXIDE INDUSTRIAL DIV., 42 S. 15th St., Philadelphia 2, Pa. Page 164.
Electrical Fittings Corp., 37-50 57 St., Woodside 77, N. Y.
Electro Dynamic Div. General Dynamics Corp., Bayonne, N. J.
Electro Lift, Inc., 204 Sargeant Ave., Clifton, N. J.
Electro Products Laboratories, 4501 North Ravenswood Ave., Chicago, Ill.
Electro Refractories & Abrasives Corp., Willets Rd., Buffalo 19, N. Y.
ELEKTROKEMISK A. S., 101 Park Ave., New York, N. Y. Page 220.
Elgin Corp., Silver City, New Mexico.
Elgin National Watch Co., 2435 N. Naomi St., Burbank, Calif.
Elkhart Brass Mfg. Co., Inc., 1302 W. Beardsley Ave., Elkhart, Ind.
Ellicott Machine Corp., 1657 Bush St., Baltimore 30, Md.
Elliott Co., 900 North Fourth Ave., Jeannette, Pa.
Elliott Service Co., Inc., 30 North MacQuesten Pkwy., Mt. Vernon, N. Y.
Elreco Corp., 2900 Cormany Ave., Cincinnati 25, Ohio.
Emery Industries, Inc., Carew Tower, Cincinnati 2, Ohio.
Empire Steel Castings, Inc., Box 139, Reading, Pa.
Endicott Forging & Mfg. Co., 1901 North St., Endicott, N. Y.
Engelhard, Inc., Charles, 850 Passaic Ave., East Newark, N. J.
Engineers Syndicate, Ltd., 5011 Hollywood Blvd., Hollywood, Calif.
Enley Products, Inc., 1236 Broadway, Brooklyn 21, N. Y.
ENSIGN-BICKFORD CO., Simsbury, Conn. Page 4.
Ensign Electric & Mfg. Co., 914 Adams Ave., Huntington 4, W. Va.
Enterprise Wheel & Car Corp., Bristol, Va.
EQUIPMENT ENGINEERS INC., 41 Sutter St., San Francisco 4, Calif. Page 176.
Equitable Paper Bag Co., Inc., 45-50 Van Dam St., Long Island City 1, N. Y
Equitable Powder Mfg. Co., East Alton, Ill.
Erie Pump & Engine Works, 144 Glenwood Ave., Medina, N. Y.
Erie Strayer Co., Erie, Pa.
Eriez Mfg. Co., 202 Magnet Dr., Erie, Pa.
Essex Wire Corp., Paranite Wire & Cable Div., 1601 Wall St., Fort Wayne 6, Ind.
Esslck Manufacturing Co., 1950 Santa Fe Ave., Los Angeles 21, Calif.
Esso Standard Oil Co., National & Comm. Sales Div., 15 West 51st St., New York 19, N. Y.
Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis 6, Ind.
Ettco Wire & Cable Corp., 75 Onderdonk Ave., Brooklyn 37, N. Y.
Euclid Div. General Motors Corp., 1361 Chardon Rd., Cleveland 17, Ohio.
Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing 58, N. Y.
Everlasting Valve Co., 49 Fisk St., Jersey City 5, N. J.
Exolon Co., East Niagara St., Tonawanda, N. Y.

F. A. B. Mfg. Co., 1249—67th St., Oakland 8, Calif.
Fafnir Bearing Co., 37 Booth St., New Britain, Conn.
Fahrenwald Co., A. W., E. 3500 Riverside, Spokane, Wash.
Failing Co., George E., Enid, Okla.
Fairbanks Co., 393 Lafayette St., New York 3, N. Y.
Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Ill.
Fairchild Aerial Surveys, Inc., 224 E. 11th St., Los Angeles, Calif.
Falcon Alarm Co., Inc., 243 Broad St., Summit, N. J.
FALK CORP., 3049 West Canal St., Milwaukee 1, Wis. Page 160.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Farrell-Cheek Steel Co., Sandusky, Ohio.
Farris Flexible Valve Corp., 463 Commercial Ave., Palisades Park, N. J.
Farval Corp., 3249 East 80th St., Cleveland 4, Ohio.
Fawick Airflex Co., Inc., 9919 Clinton Ave., Cleveland 11, Ohio.
Federal Bearings Co., Inc., Poughkeepsie, N. Y.
Federal-Mogul Service Div. Federal-Mogul-Bower Bearings, Inc., 11031 Shoemaker, Detroit 13, Mich.
Federal Motor Truck Div. Napco Industries Inc., 7th St.—N. Lyndale Minneapolis 11, Minn.
Federal Pacific Electric Co., 50 Paris St., Newark 5, N. J.
Federal Pacific Electric Co. Pacific Switchgear Div., 5815 Third St., San Francisco 24, Calif.
FEDERAL SIGN & SIGNAL CORP., 8763 South State St., Chicago 19, Ill. Page 244.
Federal Telephone & Radio Div. International Telephone and Telegraph Corp., 100 Kingsland Rd., Clifton, N. J.
Felt Products Mfg. Co., 1506 Carroll Ave., Chicago 7, Ill.
Femco, Inc., Irwin, Pa.
Filtration Engineers, Inc. Sub. of American Machine & Metals, Inc., 155 Oration St., Newark 4, N. J.
Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30, Pa.
Fischer & Porter Co., 415 Warminster Rd., Hatboro, Pa.
Fisher Research Laboratory, Inc., 1961 University Ave., Palo Alto, Calif.
Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.
Fiske Bros. Refining Co. Lubriplate Div., 129 Lockwood St., Newark 5, N. J.
Fitz Simons & Connell Dredge & Dock Co., 10 South LaSalle St., Chicago 3, Ill.
Fletcher & Co., J. H., 707 W. 7th St., Huntington, W. Va.
FLEXAUST CO., 100 Park Ave., New York 17, N. Y. Page 241.
Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill.
Flexible Tubing Co., Guilford, Conn.
Flexo Products, Inc., 1468-70 West 9th St., Cleveland 13, Ohio.
Flocker & Co., John, 644 Grant St., Pittsburgh 19, Pa.
Flood City Brass & Elec. Co., Johnstown, Pa.
FLY ASH ARRESTOR CORP., P. O. Box 1883, Birmingham 1, Ala. Page 198.
Foley Bros. Construction Co., Pleasantville, N. Y.
Food Machinery & Chemical Corp. Packing Equipment Div., P. O. Box 552, Riverside, Calif.
Food Machinery & Chemical Corp. Peerless Pump Div., 301 West Ave. 26, Los Angeles 31, Calif.
Food Machinery & Chemical Corp. Westvaco Mineral Products Div. Westvaco Chlor-Alkali Div., 161 E. 42nd St., New York 17, N. Y.
Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill.
Ford Motor Co., P. O. Box 658, Dearborn, Mich.
Forker Corp., 2044 Random Rd., Cleveland 6, Ohio.
Formica Corp. Subsidiary of Cyanamid, 4614 Spring Grove Ave., Cincinnati 32, Ohio.
Foster Co., L. B., P. O. Box 1647, Pittsburgh 30, Pa.
Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.
Four Wheel Drive Auto Co., Clintonville, Wis.
Foxboro Co., Foxboro, Mass.
Frank, M. K., 480 Lexington Ave., New York 17, N. Y.
Franklin Plastics Co., 315 Grant St., Franklin, Pa.
Frantz Co., Inc. S. G., Brunswick Pike & Kline Ave., P. O. Box 1138, Trenton 6, N. J.
Frazier Davis Construction Co., 1319 Macklind Ave., St. Louis, Mo.
Frog, Switch & Mfg. Co., Carlisle, Pa.
Fruehauf Trailer Co., 10940 Harper Ave., Detroit 32, Mich.
Fuel Process Co., D at 10th St., South Charleston, W. Va.
Fuller Co., Catasauqua, Pa.
Fuller Manufacturing Co., 1410 North Burdick St., Kalamazoo, Mich.
Fulton Bag & Cotton Mills General Office, Bag Div., 1400 Annunciation St., New Orleans 13, La.
Fyr-Fyter Co., 221 Crane St., Dayton 1, Ohio.

G. & W. Electric Specialty Co., 3500 W. 127th St., Blue Island, Ill.
GALIGHER CO., P. O. Box 209, Salt Lake City 10, Utah. Page 203.
Galion Allsteel Body Co., Galion, Ohio.
Galion Iron Works, Galion, Ohio.
Galland Henning Mfg. Co. Nopak Div., 2753 South 31st St., Milwaukee 46, Wis.
Gar Wood Industries, Inc., Wayne, Mich.
GARDNER DENVER CO., Quincy, Ill. Page 142.
Garlock Packing Co., 402 East Main St., Palmyra, N. Y.
Gates Engrg. Co., 100 South West St., Wilmington 99, Del.
GATES RUBBER CO., 999 South Broadway, Denver 17, Colo. Page 204.
Gatke Corp., 228 N. LaSalle St., Chicago 1, Ill.
General American Transportation Corp., 135 South LaSalle St., Chicago 90, Ill.
General American Transportation Corp., Louisville Dryer Div., 139 South Fourth St., Louisville, Ky.
General Cable Corp., 420 Lexington Ave., New York 17, N. Y.
GENERAL CHEMICAL DIV. ALLIED CHEMICAL & DYE CORP., Baker & Adamson Products, 40 Rector St., New York 6, N. Y. Page 236.
General Electric Co., Apparatus Sales Div., Schenectady 5, N. Y.
General Electric Co. Construction Materials Div., 1285 Boston Ave., Bridgeport 2, Conn.
General Electric Co. Gear Motor & Transmission Components Dept., 845 E. 25th St., Patterson, N. J.
General Electric Co. Ind. Haulage Div.-Loco. & Car Equip. Divs., 2901 East Lake Rd., Erie, Pa.
General Equipment & Mfg. Co., 120 S. Campbell St., Louisville, Ky.
General Mills, Inc., Fourth St. & Second Ave., S., Minneapolis, Minn.
General Motors Corp. Allison Div., 4700 West Tenth St., Indianapolis 6, Ind.
General Motors Corp. Electro-Motive Div., La Grange, Ill.
General Motors Corp. Hyatt Bearings Div., 427 Middlesex St., Harrison, N. J.
General Nuclear Corp., 550 Fifth Ave., New York 38, N. Y.
GENERAL REFRACTORIES, CO., 1520 Locust St., Philadelphia, Pa. Page 189.
General Splice Corp., 18 Marshall St., South Norwalk, Conn.
General Steel Warehouse Co., Inc. Gensco Tool Div., 1830 North Kostner Ave., Chicago 39, Ill.
General Switch Co., Div. Norbute Corp., 45 Roebling St., Brooklyn 11, N. Y.
Geo-Optic Co., Inc., 149 Church St., New York 7, N. Y.
Geophysical Instrument & Supply Co., 1201 Broadway, Denver 2, Colorado.
Georgia Iron Works Co., 605 12th St., Augusta, Ga.
Gerber Scientific Instrument Co., 162 State St., Hartford 1, Conn.
Gering Products, Inc., North Seventh St., Kenilworth, N. J.
Getman Brothers, U. S. 31, South Haven, Mich.
Glant Grip Mfg. Co., 29 Osceola St., Oshkosh, Wis.
Gibraltar Equipment & Mfg. Co., P. O. Box 304, Alton, Ill.
Gilson Screen Co., 110 Center St., Malinta, Ohio.
GODOY & CO., INC., E. A., 25 Broadway, New York 4, N. Y. Page 202.
Goldak Co., Inc., 1544 West Glenoaks Blvd., Glendale 1, Calif.
Golden-Anderson Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa.
Goodall Brothers, 46 S. Main St., Helena, Mont.
Goodall Rubber Co., Whitehead Rd., Trenton, N. J.
Goodrich Co., B. F. Truck & Bus Tire Dept., 500 South Main St., Akron 18, Ohio.
Goodrich Industrial Products Co., B. F., 476 Main St., Akron 11, Ohio.
Goodyear Tire & Rubber Co., 1144 East Market St., Akron 16, Ohio.
Goodyear Tire & Rubber Co. Industrial Products, 1144 East Market St., Akron, Ohio.
Gorman Rupp Co., Mansfield, Ohio.
GOULD CO., GORDON I., 58 Sutter St., San Francisco 4, Calif. Page 238.
Gould-National Batteries, Inc., Trenton 7, N. J.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Goyne Pump Co., Ashland, Pa.
Grace & Co., W. R., Hanover Square, New York, N. Y.
Gramm Trailer Corp., 425 E. O'Connor St., Lima, Ohio.
Graton & Knight Co. Inc., 356 Franklin St., Worcester 4, Mass.
Graver Tank & Mfg. Co., Inc., East Chicago, Ind.
Graver Water Conditioning Co., 216 W. 14th St., New York 11, N. Y.
Gray & Co., Inc., 60-11th Ave., N. E., Minneapolis 13, Minn.
Gray Instrument Co., 200 E. Church Lane, Philadelphia 44, Pa.
Graybar Elec. Co., Inc., 420 Lexington Ave., New York 17, N. Y.
Green Fire Brick Co., A. P., Mexico, Mo.
Greene, Tweed & Co., North Wales, Pa.
Gregg Co. Ltd., 241 Main St., Hackensack, N. J.
GRINNELL CO., INC., 260 West Exchange St., Providence 1, R. I. Page 247.
Griphoist, Inc., 424 Bryant St., San Francisco 9, Calif.
Gruendler Crusher & Pulverizer Co., 2915 North Market St., St. Louis 6, Mo.
Gulf Oil Corp., 1822 Gulf Bldg., Pittsburgh 30, Pa.
Gundlach Machine Co., T. J. Div. of JMJ Industries, Inc., 226 Centreville Ave., Belleville, Ill.
Gurley, W. & L. E., 514 Fulton St., Troy, N. Y.
Gustin-Bacon Mfg. Co., 210 West Tenth St., Kansas City, Mo.
Guyan Machy. Co., 755 Stratton, Logan, W. Va.
Gwilliam Co., 360 Furman St., Brooklyn 1, N. Y.

H-B Instrument Co., Inc., American & Bristol Sts., Philadelphia 40, Pa.
H. & L. Tooth Co., 1540 South Greenwood Ave., Montebello, Calif.
Hack Engineering Co., 124 Wazee Market, Denver, Colo.
Haesler Metal & Ore Corp., 11 West 42 St., New York, N. Y.
Hagan Chemicals & Controls, Inc., Divisions: Calgon Co., Hall Laboratories, Hagan Bldg., Pittsburgh 30, Pa.
Hales Co., W. M., Box 65, 700 Commerce St., Danville, Ill.
Hall & Sons, Amos H., 5500 N. Water St., Philadelphia 20, Pa.
Hallett Diesel Engine Div. American M.A.R.C., Inc., 1601 W. Florence Ave., Inglewood, Calif.
Hamer Valves, Inc., P. O. Box 1851, Long Beach 1, Calif.
Hamilton Rubber Mfg. Corp., Meade St., Trenton, N. J.
HAMMOND CO., J. V., Spangler, Pa. Page 242.
Handy & Harman, 82 Fulton St., New York 38, N. Y.
Hanks, Inc., Abbot A., 624 Sacramento St., San Francisco 11, Calif.
Hapman Conveyors, Inc., 630 Gibson St., Kalamazoo 6, Mich.
HARBISON-WALKER REFRACTORIES CO., 307 Fifth Ave., Pittsburgh 22, Pa. Page 210.
HARDINGE CO., INC., 240 Arch St., York, Pa. Page 212.
HARNISCHFEGER CORP., 4400 W. National Ave., Milwaukee 46, Wis. Page 179.
HARNISCHFEGER CORP., P & H Diesel Div., Crystal Lake, Ill. Page 179.
Harper Electric Furnace Corp., 39 River St., Buffalo 2, N. Y.
Harrington Co. Gravers Rd. at the Turnpike, Plymouth Meeting, Pa.
Hart Mfg., Co., 119 Bartholomew Ave., Hartford, Conn.
Hartzell Propeller Fan Co., P. O. Box 909, Piqua, Ohio.
Hauck Manufacturing Co., 126 Tenth St., Brooklyn 15, N. Y.
Hauser-Stander Tank Co., 4820 Spring Grove Ave., Cincinnati 32, Ohio.
Havlick, J. L., 112 S. Cedar St., Spokane, Wash.
Hawley & Hawley, Douglas, Ariz.
Hawthorne, Inc., Herb J., Box 7366, Houston 8, Tex.
Hayes Steel Products, Ltd., Merritton, Ontario, Canada.

Haynes Stellite Co. Div. Union Carbide Corp., Kokomo, Ind.
Hayward Co., 50 Church St., New York, N. Y.
Hazemag m. b. H., c/o R. E. Kleinhans 122 East 42nd St., New York 17, N. Y.
Heil Co., 3000 W. Montana, Milwaukee, Wis.
Heineken, Inc. W. P., 50 Broad St., New York, N. Y.
Heinemann Electric Co., 98 Plum St., Trenton 2, N. J.
Heintz Mfg. Co., 13110 Enterprise Ave., Cleveland 11, Ohio.
Helmick Foundry-Machine Co., P. O. Box 71, Fairmont, W. Va.
Helwig Co., 2544 N. 30th St., Milwaukee 10, Wis.
Hendrick Mfg. Co., Carbondale, Pa.
Hendrickson Mfg. Co., 8001 W. 47th St., Lyons, Ill.
Hendrix Mfg. Co., Mansfield, La.
HERCULES POWDER CO., 933 King St., Wilmington, Del., Page 227.
Hercules Steel Products Corp., Galion, Ohio.
Herold Manufacturing Co., 215 Hickory St., Scranton 5, Penna.
Hertner Electric Co., 12690 Elmwood Ave., N. W., Cleveland 11, Ohio.
Hevi-Duty Electric Co., 2040 W. Wisconsin Ave., Milwaukee 1, Wis.
HEWITT-ROBINS, INC., 666 Glenbrook Rd., Stamford, Conn. Page 172.
Heyden Newport Chemical Corp., 342 Madison Ave., New York, New York.
Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa.
Hill & Jude, Assayers, 800 Pearl St., Boulder, Colo.
Hiller Helicopters, 1350 Willow Rd., Palo Alto, Calif.
Hills-McCanna Co., 3025 N. Western Ave., Chicago 18, Ill.
Hirsch Bros. Machy. Co., P. O. Box 226, El Paso, Tex.
Hisey-Wolf Machine Co., Galvin & Mt. Hope Aves., Cincinnati 4, Ohio.
Hobart Bros. Co., Main & Adams St., Troy 1, Ohio.
Hockensmith Corp., Penn, Pa.
HOFFMAN BROS. DRILLING CO., Tiona St. Ext., Punxsutawney, Pa. Page 245.
Holman Bros.—Canada Ltd., 97 Kent Ave., Kitchener, Ontario, Canada.
Holmes & Bros., Inc. Robert, 570 Junction Ave., Danville, Ill.
Homer Mfg. Co., Lima, Ohio.
Hose-McCann Telephone Co., 25th St. & Third Ave., Brooklyn 32, N. Y.
HOSSFELD MFG. CO., Winona, Minn. Page 202.
Hough Co., Frank G., 737 Fairview Ave., Libertyville, Ill.
Houghton & Co., E. F., 303 W. Lehigh Ave., Philadelphia 33, Pa.
House & Sons, Inc. Chas. W., Unionville, Conn.
Howe Scale Co., Inc., Rutland, Vt.
Howell Electric Motors Co., Howell, Mich.
Hoyland Steel Co., Inc., 5104 Chrysler Bldg., 405 Lexington Ave., New York, N. Y.
Hoyt Wire Cloth Co., Box 22, Lancaster, Pa.
Hughes Tool Co., 300 Hughes, Houston, Tex.
Hulburt Oil & Grease Co., Trenton & Castor Aves., Philadelphia 34, Pa.
HUMPHREYS INVESTMENT CO., Engineering Div., 915 First National Bank Bldg. Denver 2, Colo. Page 243.
Hunt & Son, Inc., C. B., Salem, Ohio.
Hycon Aerial Surveys, Inc., 1020 S. Arroyo Pkwy., Pasadena, Calif.
Hypro Engineering, Inc., 700 39 Ave., N. E., Minneapolis 21, Minn.
Hyster Co., 2965 N. E. Clackamas St., Box 4318, Portland 8, Ore.

I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia 30, Pa.
Ideal Electric & Mfg. Co., Mansfield, Ohio.
Ideal Industries, Inc. 1020 Park Ave., Sycamore, Ill.
Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.
Illinois Iron & Bolt Co., 1932 Thomas St., Carpentersville, Ill.
Illinois Powder Mfg. Co., 506 Olive St., St. Louis 1, Mo.
Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago 10, Ill.
Imperial-Cantrell Mfg. Co., P. O. Box 538, Jellico, Tenn.
Imperial Electric Co., 63 Ira Ave., Akron 9, Ohio.
Indiana Foundry Co., Indiana, Pa.
Industrial Air Products Co., 3200 N. W. Yeon Ave., Portland 10, Ore.
Industrial Brownhoist Corp., 135 Washington Ave., Bay City, Mich.
Industrial Engrg. & Construction Co., First National Bank Bldg., Fairmont, W. Va.
Industrial Gloves Co., 700 Garfield St., Danville, Ill.
Industrial Overlay Metals, Inc., 410 N. Barron St., Eaton, Ohio.
Industrial Physics & Electronics Co., 470 South Tenth East St., Salt Lake City 2, Utah.
Infilco, Inc., 901 S. Campbell Ave., Tucson, Ariz.
INGERSOLL-RAND CO., 11 Broadway, New York 4, N. Y. Page 8.
Inland Steel Co., 38 S. Dearborn St., Chicago 3, Ill.
Inland Steel Products Co., 4101 W. Burnham St., Milwaukee 1, Wis.
Insley Manufacturing Corp., 801 N. Olney St., Indianapolis 6, Ind.
INTERNATIONAL BARTERING CO., 52 Broadway, New York, N. Y. Page 236.
International Harvester Co., Motor Truck Div., 180 North Michigan Ave., Chicago 1, Ill.
International Harvester Export Co., 180 No. Michigan Ave., Chicago 1, Ill.
INTERNATIONAL MINERALS & METALS CORP., 11 Broadway, New York 4, N. Y. Page 246.
International Nickel Co., 67 Wall St., New York 5, N. Y.
International Salt Co., Scranton 2, Pa.
International Shoe Co., 1509 Washington Ave., St. Louis 3, Mo.
Interstate Drop Forge Co., 4051 27th St., Milwaukee 16, Wis.
Ionics, Inc., 152 Sixth St., Cambridge 42, Mass.
IOWA MFG. CO., 916-16th St., N. E., Cedar Rapids, Iowa. Page 191.
Ironton Engine Co., Farmingdale, N. J.
Ironton Fire Brick Co., Ironton, Ohio.
Irving Subway Grating Co., Inc., 50-99 27th St., Long Island City 1, N. Y.
Irvington Div. Minnesota Mining & Mfg. Co., 6 Argyle Terrace, Irvington 11, N. J.
Irwin Foundry & Mine Car Co., Box 311, Irwin, Pa.
Isotope Products, Inc., Instrument Div., 1717 Elmwood Pierce Arrow, Buffalo, N. Y.

Jacuzzi Bros., Inc., Richmond, Calif.
Jaeger Machine Co., 550 W. Spring St., Columbus 16, Ohio.
Jarrell-Ash Co., 28 Farwell St., Newtonville 60, Mass.
Jefferson Union Co., 31 Fletcher Ave., Lexington, Mass.
Jeffrey Mfg. Co., 974 N. Fourth St., Columbus 16, Ohio.
Jenkins Bros., 100 Park Ave., New York 17, N. Y.
Jesco Lubricants Co., P. O. Box 7331, Kansas City 16, Mo.
Jessop Steel Co., 538 Green St., Washington, Pa.
Jet-Lube, Inc., 3093 North California St., Burbank, Calif.
Johns-Manville, 22 E. 40th St., New York 16, N. Y.
Johnson Aircraft Co., 39 Hanover Ave., Morris Plains, N. J.
Johnson Belting Co., 44 Hubert St., New York 13, N. Y.
Johnson Loading Supplies, G. R., 5026 Butterworth Rd., Mercer Island, Wash.
Johnson Bronze Co., 492 S. Mill St., New Castle, Pa.
Johnson Co., C. S., Champaign, Ill.
Johnson Corp., 816 Wood St., Three Rivers, Mich.
Johnson-March Corp., 1724 Chestnut St., Philadelphia 3, Pa.
Johnson Plastic Corp., 201 Brown Rd., Chagrin Falls, Ohio.
Johnson Co., R. G., 831 Wash. Trust Bldg., Washington, Pa.
Johnston-Morehouse-Dickey Co., 704 Second Ave., Pittsburgh 19, Pa.
Johnston Pump Co., 3272 E. Foothill Blvd., Pasadena 8, Calif.
JONES & LAUGHLIN STEEL CORP., 3 Gateway Center, Pittsburgh 30, Pa. Pages 175, 193.
JOY MFG. CO., Henry W. Oliver Bldg., Pittsburgh 22, Pa. Page 162.
Joyce-Cridland Co., 2027 E. First St., Dayton, Ohio.
Judsen Rubber Works, Inc., 4107 West Kinzie St., Chicago 24, Ill.
Justrite Mfg. Co., 2061 Southport Ave., Chicago 14, Ill.

K. W. Battery Co., 3555 Howard St., Skokie, Ill.
Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif.
Kaiser Engineers, 1924 Broadway, Oakland, Calif.
Kanawha Mfg. Co., 1520 Dixie St., Charleston 1, W. Va.
Kansas City Hay Prsss, 801 Woodswether Rd., Kansas City, Mo.
Kato Engineering Co., Mankato, Minn.
Kaydon Engineering Corp., Muskegon, Mich.
Keasbey & Mattison Co., Ambler, Pa.
Keeler Co., E., 238 West St., Williamsport 3, Pa.
Keeney Co., Paul E., 1125 S. E. Grand Ave., Portland 14, Ore.
Kellogg Co., M. W., 711 Third Ave., New York 17, N. Y.
KENNAMETAL INC., MINING TOOL DIV., Bedford, Pa. Page 168.
Kennedy Valve Mfg. Co., Elmira, N. Y.
KENNEDY-VAN SAUN MFG. & ENG. CORP., 2 Park Ave., New York, N. Y. Page 16.
Kensington Steel Co., 505 Kensington Ave., Chicago 28, Ill.
Kenworth Motor Truck Co., Div. Pacific Car and Foundry Co., 8801 East Marginal Way, Seattle 24, Wash.
Kenyon Walker Machinery Co., 1600 11th St., Denver 2, Colorado.
Kerite Co., 30 Church St., New York 7, N. Y.
KERN INSTRUMENTS, INC., 120 Grand St., White Plains, N. Y. Page 225.
Kersey Mfg. Co., Inc., P. O. Box 151, Bluefield, W. Va.
Keuffel & Esser Co., 300 Adams St., Hoboken, N. J.
Keystone Carbon Co., State St., St. Marys, Pa.
Keystone Lubrication Co., 21st & Clearfield Sts., Philadelphia 32, Pa.
Kidde & Co., Inc., Walter, 956 Main St., Belleville 9, N. J.
Kieley & Mueller, Inc., 64 Gemung St., Middletown, N. Y.
Killark Electric Mfg. Co., 3940 Easton Ave., St. Louis, Mo.
King Powder Co., 1703 First National Bank Bldg., Cincinnati 2, Ohio.
Kirk & Blum Mfg. Co., 3150 Forrer St., Cincinnati 9, Ohio.
Klemp Metal Grating Corp., 6613 S. Melvina Ave., Chicago 38, Ill.
Klipfel Valves, Inc., 1075 Lincoln Ave., Hamilton, Ohio.
Knopp, Inc., 4224 Holden St., Oakland 8, Calif.
Kobe, Inc., 3040 E. Slauson Ave., Huntington Park, Calif.
Koebel Diamond Tool Co., 9456 Grinnell Detroit 13, Mich.
Koehring Co., 3026 West Concordia, Milwaukee 16, Wis.
Kolton Electric Mfg. Co., 123 New Jersey R. R. Ave., Newark 5, N. J.
Koppers Co. Inc., Koppers Bldg., Pittsburgh 19, Pa.
Koppers Co., Inc., Metal Prod. Div., 200 Scott St., Baltimore 30, Md.
Korb-Pettit Wire Fabrics & Iron Works, 1501-15 N. Mascher St., Philadelphia 22, Pa.
Kraft Bag Corp., 630 Fifth Ave., New York, N. Y.
Kremser & Sons, Inc. Frank A., P. O. Box 6207 Holmesburg Sta., Philadelphia 36, Pa.
Krogh Pump & Equipment Co., Inc., 515 Harrison St., San Francisco 5, Calif.
Kuhlman Electric Co., 26th & Jefferson Sts., Bay City, Mich.
Kurz & Root Co., 232 E. North Island St., Appleton, Wis.
Kwik-Mix Co., Koehring Div., 235 W. Grand Ave., Port Washington, Wis.

Laclede-Christy Div., H. K. Porter Company Inc, 2000 Hampton Ave, St Louis 10 Mo.
Ladish Co., Cudahy, Wis.
Lake Shore, Inc., Lake Shore Engineering Div., Iron Mountain, Mich.
Lake Shore Electric Mfg. Corp., 207 Willis St., Bedford, Ohio.
Lakeside Bridge & Steel Co, 5306 North 33rd St, Milwaukee 9 Wis.
Lamson Corp, 210 Lamson St, Syracuse 1, N. Y.
Lamson & Sessions Co, 1971 West 85th St., Cleveland 2, Ohio.
Landis Steel Co., 116 West A St., Box 248, Picher, Okla.
Laubenstein Mfg. Co., 422 S. Third St., Ashland, Pa.
Lawrence Pumps, Inc., 371 Market St., Lawrence, Mass.
Laylander, Philip A., Box 4395, Tucson, Ariz.
Layne & Bowler Pump Co. of Los Angeles, 2943 South Vail Ave., Los Angeles 22, Calif.
Leavitt Machine Co., Orange, Mass.
Lebanon Steel Foundry, Lebanon, Pa.
Lebus Mfg. Co., Subsidiary of American Hoist & Derrick Co., Longview, Texas.
Lecco Machinery & Engineering Co., Box 3036, Bluefield, West Va.
Lecourtenay Co., 5 Maine St., Newark 5, N. J.
Lectromelt Furnace Co., Div. McGraw Electric Co. P O Box 1257, Pittsburgh 30, Pa.
Ledeen Inc., 3250 North Gilman Rd., El Monte, Calif.
LEDOUX & CO., 359 Alfred Ave., Teaneck, N. J. Page 246
Lee-Norse Co, 751 Lincoln Ave, North Charleroi, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Leetonia Tool Co., 142 Main St., Leetonia, Ohio.
Leffel & Co., James, 426 East St., Springfield, Ohio.
LE-HI Div. Hose Accessories Co., 17th St. & Lehigh Ave., Philadelphia 32, Pa.
Leland Electric Co. Div., American Machine & Foundry Co., 1501 Webster St., Dayton 1, Ohio.
LE ROI DIV. WESTINGHOUSE AIR BRAKE CO., Milwaukee 1, Wis. Page 174
Leschen Wire Rope Div, H K Porter Company, Inc., 2727 Hamilton Ave., St. Louis 12, Mo.
LE TOURNEAU-WESTINGHOUSE CO, P O Box 240, Peoria, Ill. Pages 10-15
Leupold & Stevens Instruments Inc, 4445 N. E. Glisan St., Portland 13, Ore.
Lewellen Mfg. Co., 1428 Tenth St., Columbus, Ind.
Lewis Bolt & Nut Co., 504 Malcolm Ave., S. E., Minneapolis 14, Minn.
Lidgerwood Industries, Inc., 7 Dey St., New York N Y.
Lilie-Hoffman Cooling Towers, Inc., 1450 So. Vandeventer, St. Louis 10, Mo.
Lima Electric Motor Co., Findlay Rd., Lima, Ohio.
LINATEX CORP OF AMERICA, Rockville, Conn. Page 221.
Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17, Ohio.
Lincoln Engineering Co., Div. McNeil Machine & Engineering Co., 5701 Natural Bridge, St. Louis 20, Mo.
Linde Co., Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.
Line Material Industries, McGraw-Edison Co., 700 W. Michigan St., Milwaukee 1, Wis.
LINK-BELT CO., Dept. EMJ-57 Prudential Plaza, Chicago 1, Ill. Page 3.
Link-Belt Speeder Corp., 1201 6th St., S. W., Cedar Rapids, Iowa.
Lippmann Engineering Works, Inc., 4603 W. Mitchell St., Milwaukee, Wis.
Lister-Blackstone, Inc., 42-32 21st St., Long Island City 1, N. Y.
Lockrey Co., Southampton, N. Y.
LOGAN ENGINEERING CO., 4901 West Lawrence St., Chicago 30, Ill. Page 253.
Lonergan Co., J. E., Second & Race Sts., Philadelphia 6, Pa.
Long Co., Box 311, Oak Hill, W. Va.
LONGYEAR CO., E. J., 1700 Foshay Tower, Minneapolis 2, Minn. Page 161
Los Angeles Steel Casting Co., 6100 South Boyle, Los Angeles 58, Calif.
Louden Machinery Co., 607 Broadway, Fairfield, Iowa.
Lovejoy Flexible Coupling Co., 4932 W. Lake St., Chicago 44, Ill.
Ludlow-Saylor Wire Cloth Co., 634 S. Newstead, St. Louis 10, Mo.
Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.
Lukens Steel Co., Coatesville, Pa.
Lumen Bearing Co., 197 Lathrop St., Buffalo 12, N. Y.
Lundberg Explorations, Ltd., 96 Eglinton Ave. E., Toronto, Ontario, Canada.
Lunkenheimer Co., Beekman St. & Waverly Ave., Cincinnati 14, Ohio.
Luzerne Rubber Co., Muirhead & Dewey Sts., Trenton 7, N. J.

Macbeth Daylighting Corp., Newburgh, N. Y.
MACE CO., 2763 Blake St., Denver 5, Colo. Page 235.
Machinery Center Inc., P. O. Box 964—1201 South 6th West, Salt Lake City 10, Utah.
Macklin Co., 1936 Lawrence Blvd., Jackson, Mich.
Mack Trucks, Inc., 1355 West Front St., Plainfield, N. J.
Macwhyte Co., 2937 14th Ave., Kenosha, Wis.
Madesco Tackle Block Co., Easton, Pa.
Magnetic Engineering & Mfg. Co., 852 Van Houten Ave., Clifton, N. J.
Magor Car Corp., 50 Church St., New York 7, N. Y.
Mahon Co., R. C., P. O. Box 4666, Detroit 34, Mich.
Majac Inc., 23rd St., Sharpsburg 15, Pa.
Mallinckrodt Chemical Works, 2nd & Mallinckrodt Sts., St. Louis 7, Mo.
Mancha Storage Battery Locomotive Div. Goodman Mfg. Co., Halsted St. & 48th Pl., Chicago 9, Ill.
Manganese Steel Forge Co., Allen St. & Castor Ave., Philadelphia 34, Pa.
Manheim Mfg. & Belting Co., 470 Stiegel St., Manheim, Pa.
Manitowoc Engineering Corp., South 16th St., Manitowoc, Wis.
Manning, Maxwell & Moore, Inc. Shaw Box Crane & Hoist Div., Muskegon, Mich.
Manu-Mine Research & Devel. Co., P. O. Box 167, Reading, Pa.
Manzel Div. Houdaille Industries, Inc., 315 Babcock St., Buffalo 10, N. Y.
Marathon Coal Bit Co. Inc., Montgomery, W. Va.

Marathon Corp. Chemical Sales Dept., Rothschild, Wis.
Marathon Electric Mfg. Corp., Wausau, Wis.
Marble Card Electric Corp., Superior St., Gladstone, Mich.
Marietta Concrete Corp., Marietta, Ohio.
Marion Metal Products Co., Cheney Ave., Marion, Ohio.
Marion Power Shovel Co., Marion, Ohio.
Markley Dust Control System, Inc., 80 Snyder Rd., Ramsey, N. J.
Marland One-Way Clutch Co., 561 Hillgrove Ave., La Grange, Ill.
Marley Co., 222 West Gregory Blvd., Kansas City 14, Mo.
Marlin-Rockwell Corp., 402 Chandler St., Jamestown, N. Y.
Marlow Pumps Div., Bell & Gossett Co., Box 200, Midland Park, N. J.
Marmon-Herrington Co., 1511 West Washington St., Indianapolis 7, Ind.
Marquette Mfg. Co., Inc., 307 E. Hennepin Ave., Minneapolis 14, Minn.
Marsh Engineering Co., E. F., 4324 W. Clayton Ave., St. Louis 10, Mo.
Martin Engineering Co., Neponset, Ill.
Martin Fan & Blower Co., 4634 W. 21st Pl., Chicago 50, Ill.
Marvel Engineering Co., 7227 N. Hamlin Ave., Chicago 45, Ill.
Maschinenfabrik Rudolf Hausherr & Soehne, GmbH, c/o B. J. Nykerk Corp., 42 Broadway, New York 4, N. Y.
Massachusetts Gear & Tool Co., 30 Nashua St., Woburn, Mass.
Master Bronze Powder Co., Inc., 538-548 West State St., Calumet City, Ill.
Master Builders Co., 7016 Euclid Ave., Cleveland 3, Ohio.
Master Electric Co., 126 Davis Ave., Dayton 1, Ohio.
Master Mfg. Co., Hutchinson, Kan.
Maxi Corp., P. O. Box 3129, Terminal Annex, Los Angeles 54, Calif.
Mayhew Machine & Supply Co., P. O. Box 7726, Dallas, Tex.
MAYO TUNNEL & MINE EQUIPMENT CO., Box 1413, Lancaster, Pa. Page 206.
McClintock Co., R. S., W. 418 Second Ave., Spokane, Wash.
McDonald Mfg. Co., A. Y., 12th & Pine Sts., Dubuque, Iowa.
McDonald Drilling Co., Inc., 14408 St. Marys Ave., Detroit 27, Mich.
McDowell Co., Inc., 3203 W. 71st St., Cleveland 2, Ohio.
McGill Mfg. Co., Inc., 1151 N. Lafayette St., Valparaiso, Ind.
McGowan Pump Div. Leyman Mfg. Corp., 58 Central Ave., Cincinnati 2, Ohio.
McKee & Co., Arthur G., 2300 Chester Ave., Cleveland 1, Ohio.
McKiernan-Terry Corp., 505 Manor Ave., Harrison, N. J.
McKinney Drilling Co., P. O. Box 190, Nacogdoches, Tex.
McLanahan & Stone Corp., Hollidaysburg, Pa.
McMillan's Sons, W. H., 49 South St., New York, N. Y.
McNally Pittsburg Mfg. Corp., 307 W. Third St., Pittsburg, Kan.
McPhar Geophysics, Ltd., 139 Bond Ave., Don Mills, Ontario, Canada
McPhar Manufacturing, Ltd., 139 Bond Ave., Don Mills, Ontario, Can.
Mead Mill Co., 14736 Charlevoix Ave., Detroit 15, Mich.
Meckum Engineering, Inc., 53 W. Jackson Blvd., Chicago 3, Ill.
Meeker Foundry Co., 95 Clay St., Newark 4, N. J.
Memco Engineering & Mfg. Co., Commack, N. Y.
Menlo Research Laboratory, 538 Phelan Av., San Jose, Calif.
Merlam Instrument Co., 10920 Madison Ave., Cleveland 2, Ohio.
MERRICK SCALE MFG. CO., 184 Autumn St., Passaic, N. J. Page 209.
Metal Carbides Corp., 107 East Indianola Ave., Youngstown 7, Ohio.
Metallizing Engineering Co., Inc., 1101 Prospect Ave., Westbury, N. Y.
Metallo Gasket Co., 12 Bethany St., New Brunswick, N. J.
Metallurgical Products Dept. General Electric Co., 11177 East Eight Mile Rd., Detroit 32, Mich.
Metals Disintegrating Co., Inc., Pulverizing Machinery Div., Chatham Rd., Summit, N. J.
Metal & Thermit Corp., Rahway, N. J.
Metal Traders Inc., 67 Wall St., New York, N. Y.
Metron Instrument Co., 432 Lincoln St., Denver, Colo.
Mexico Refractories Co., Mexico, Mo.
Michigan Pipe Co., 6581 Mill St., Gagetown, Mich.
Micro Switch Div. Minneapolis-Honeywell Regulator Co., Freeport, Ill.
Midvale-Heppenstall, 4301 Wissahickon Ave., Philadelphia 40, Pa.
Miehle Printing Press & Mfg. Co., Star-Kimble Motor Div., 200 Bloomfield Ave., Bloomfield, N. J.
Miller Equipment Co., Inc., 13 & New Sts. Franklin (Venango County), Pa.
Milwaukee Electric Tool Corp. 5316 W. State St., Milwaukee 8, Wis.
Minerals Engineering Co., 801 Fourth Ave., Grand Junction, Colo.
Miners' Hardware Supply Co., 806 Republic Bldg., Pittsburgh 12, Pa.
MINE SAFETY APPLIANCES CO., 201 North Braddock Ave., Pittsburgh 8, Pa. Page 194.
MINE & SMELTER SUPPLY CO. Marcy Mill Div., P. O. Box 9041, Denver 16, Colo. Page 200.
Mining Machine Parts, Inc., 2701 St. Clair Ave., Cleveland 14, Ohio.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis 8, Minn.
Minneapolis-Honeywell Regulator Co., Brown Instrument Div., Wayne & Windrim Aves., Philadelphia 44, Pennsylvania.
Minneapolis-Honeywell Regulator Co. Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.
Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.
Missouri Belting Co., 1029 S. Grand Blvd., St. Louis 4, Mo.
MOBILE BUMPER INC., DIV. MOBILE DRILLING INC., 960 N. Pennsylvania St., Indianapolis 4, Ind. Page 197.
MOBILE DRILLING & ENGINEERING INC., DIV. MOBILE DRILLING INC., 960 N. Pennsylvania St., Indianapolis 4, Ind. Page 197.
MOBILE DRILLING, INC., 960 N. Pennsylvania St., Indianapolis 4, Ind. Page 197
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
Monsanto Chemical Co., 1700 S. Second St., St. Louis 4, Mo.
Moore Co., 1036 Quarrier St., Charleston, W. Va.
Moore Co. 424 Nichols Rd. Kansas City 12, Mo.
Moore Drop Forging Co., 38 Walter St., Springfield 7, Mass.
Moran Engineering Co., 7721 E. Jefferson St., Paramount, Calif.
MORCO, INC., 22201 Aurora Rd., Bedford, Ohio. Page 205.
MORRIS MACHINE WORKS, Baldwinsville, N. Y.
MORSE BROS. MACHINERY CO., P. O. Box 1708, Denver, Colo. Page 224.
Morse Chain Co., A Borg-Warner Industry, Ithaca, N. Y.
Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill.
Motorola Communications & Electronics, Inc., 4501 Augusta Blvd., Chicago 51, Ill.
Mott Core Drilling Co., 830 Eighth Ave., Huntington, W. Va.
Mt. Sopris Instrument Co., 1320 Pearl St., Boulder, Colo.
Mueller Brass Co., 1925 Lapeer Ave., Port Huron, Mich.
Mullite Works Refractories Div. H. K. Porter Company, Inc., Canal St., Shelton, Conn.
Multi Electrical Mfg. Co., 4243 W. Lake St., Chicago 24, Ill.
Multi-Metal Wire Cloth Co., Inc., 1350 Garrison Ave., New York 59, N. Y.
Murphy Diesel Co., 5317 W. Burnham St., Milwaukee 11, Wis.
Mustang Motor Products Corp., Box 1191, 635 West Colorado Blvd., Glendale 4, Calif.
Myers-Whaley Co., Inc., P. O. Box 789, Knoxville 1, Tenn.

NACHOD & U. S. SIGNAL CO., 4777 Louisville Ave., Louisville 9, Ky. Page 250.
NAGLE PUMPS, INC., 1239 Center St., Chicago Heights, Ill. Page 238.
Nash Engineering Co., 218 Wilson Rd., South Norwalk, Conn.
National Carbon Co. Div. Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.
National Carbon Co. Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.
National Cylinder Gas Co., 840 N. Michigan Ave., Chicago 11, Ill.
National Electric Products Corp., Gateway Center, 140 Stanwix St., Pittsburgh 22, Pa.
National Filter Media Corp., 1717 Dixwell Ave., New Haven 11, Conn.
National Fuse & Powder Co., 3801 Delgany St., Denver 5, Colo.
NATIONAL IRON CO., Ramsey St. & 50th Ave. W., Duluth 7, Minn. Page 229.
National Lead Co., 111 Broadway, New York 6, N. Y.
NATIONAL MALLEABLE & STEEL CASTINGS CO., 10606 Quincy Ave., Cleveland 6, Ohio. Page 141.
National Powder Co., Eldred, Pa.
NATIONAL SUPPLY CO., Two Gateway Center, Pittsburgh, Pa. Page 176.
National Tank & Pipe Co., 2301 N. Columbia Blvd., Portland 3, Ore.
National Vulcanized Fibre Co., Box 311, Wilmington 99, Del.
NAYLOR PIPE CO., 1243 E. 92nd St., Chicago 19, Ill. Page 18.
Neff & Fry Co., Camden, Ohio.
Nelson Stud Welding, Toledo Avenue at 28th St., Lorain, Ohio.
New Departure Div. General Motors Corp., Bristol, Conn.
New Jersey Meter Co., Plainfield, N. J.
New Jersey Zinc Co., 160 Front St., New York 7, N. Y.
New York Air Brake Co. Aurora Pump Div., 86 Loucks St., Aurora, Ill.
New York Belting & Packing Co., 1 Market St., Passaic, N. J.
New York Engineering Co., 75 West St., New York 6, N. Y.
New York & New Jersey Lubricant Co., 292 Madison Ave., New York 17, N. Y.
New York Rubber Corp., 100 Park Ave., New York 17, N. Y.
Newage Industries, Inc., 222 York Road, Jenkintown, Pa.
Newark Wire Cloth Co., 370 Verona Ave., Newark 4, N. J.
Newcomer Products, Inc., Latrobe, Pa.
Newhall Chain Forge & Iron Co., 11 Orchard Rd., Park Ridge, N. J.
Nice Ball Bearing Co., 30th & Hunting Park Ave., Philadelphia 40, Pa.
NICHOLS ENGINEERING & RESEARCH CORP., 70 Pine St., New York 5, N.Y.
Nife, Inc., Lambert Ave., Copiague, N.Y.
Nolan Co., 120 Pennsylvania St., Bowerston, Ohio.
NORDBERG MFG. CO., 3073 S. Chase Ave., Milwaukee 1, Wis. Page 152.
Norden-Ketay Corp., Milford, Conn.
North American Refractories Co., E. 6th at Euclid Ave., Cleveland 14, Ohio.
NORTHERN BLOWER CO., 6410 Barberton Ave., Cleveland, Ohio. Page 209.
Northern Conveyor Co., P. O. Box 46, Janesville, Wis.
Northwest Engineering Co., 135 S. La Salle St., Chicago 3, Ill.
Northwestern Electric Co., 1750 N. Springfield Ave., Chicago 47, Ill.
Norton Co., 1 New Bond St., Worcester 6, Mass.
Novo Pump & Engine Co., 702 Porter St., Lansing 5, Mich.
Nuclear-Chicago Corp., 223 W. Erie St., Chicago, Ill.
Nuclear Exploration Co., 826 East 7th St., Los Angeles 21, Calif.
Nuclear Research Corp., Second St. Pike, Southampton, Pa.

O. K. Machinery Div. John C. Motter Printing Press Co., Columbia, Pa.
Ogden Iron Works, 185 23 St., Ogden, Utah.
Ohio Brass Co., Mansfield, Ohio.
Ohio Carbon Co., 12508 Berea Rd., Cleveland 11, Ohio.
Ohio Electric Mfg. Co., 5400 Dunham Rd., Maple Heights, Ohio.
Ohio Forge & Machine Corp., 3010 Woodhill Rd., Cleveland 4, Ohio.
Ohio Gear Co., 1333 E. 179th St., Cleveland 10, Ohio.
Ohio Grease Co., 525 N. Spring St., Loudonville, Ohio.
Ohio Injector Co., 275 Main St., Wadsworth, Ohio.
Ohio Locomotive Crane Co., 1816 Southern Ave., Bucyrus, Ohio.
Ohio Oil Co., 539 South Main St., Findlay, Ohio.
Oilgear Co., 1560 W. Pierce St., Milwaukee 4, Wis.
Okadee Co., 332 S. Michigan Ave., Chicago 4, Ill.
OKONITE CO., Passaic, N. J. Page 180.
Olds Alloy Co., 4481 Mason St., South Gate, Calif.
Olin-Mathieson Chemical Corp., Explosives Div., East Alton, Ill.
Oliver Corp., 400 West Madison, Chicago 6, Ill.
Oliver Corp., A. B. Farquhar Div., 142 N. Duke St., York, Pa.
OMEGA MACHINE CO., DIV. B-I-F INDUSTRIES, 345 Harris Ave., Providence 1, R. I.
Onan & Sons, Inc., D. W., University Ave. S. E. at 25th, Minneapolis 14, Minn.
Orange Roller Bearing Co., Inc., 557 Main St., Orange, N. J.
Ore & Chemical Corp., 80 Broad St., New York, N. Y.
Oronite Chemical Co., 200 Bush St., San Francisco, Calif.
Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago 5, Ill.
Oshkosh Motor Truck, Inc., 2300 Oregon St., Oshkosh, Wis.
Osmose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.
Ottumwa Box Car Loader Co., Ottumwa, Iowa.
Overseas Raw Materials Corp., 11 Broadway, New York, N. Y.
Overstrom & Sons, Inc., 2213 West Mission Rd., Alhambra, Calif.
Owatonna Tool Co., 353 Cedar St., Owatonna, Minn.
Owen Bucket Co., 6001 Breakwater Ave. Cleveland 2, Ohio.
Ozalid Div. General Aniline & Film Corp., Ansco Rd., Johnson City, N. Y.

Pacific Coast Engineering Co., Oak and Clement Sts., Alameda, Calif.
Pacific Foundry Co., Ltd., 3100—19th St., San Francisco 10, Calif.
Pacific Lumber Co., 100 Bush St., San Francisco, Calif.
Pacific Wire Rope Co., 1840 E. 15th St., Los Angeles 21, Calif.
Pacific Wood Tank Corp., 461 Market St., San Francisco 5, Calif.
Packsack Diamond Drills, Ltd., 1385 Hammond St., North Bay, Ontario, Canada.
Page Engineering Co., Clearing Post Office, Chicago 38, Ill.
Palnut Co., Glen Rd., Mountainside, N.J.
Pangborn Corp., 630 Pangborn Blvd., Hagerstown, Md.
Paragon Electric Co., 1600 12 St., Two Rivers, Wis.
Paragon-Revolute Corp., 97 South Ave., Rochester 4, N. Y.
Parker Electrical Mfg. Co., 221 Washington St., Oakland 7, Calif.
Parker Safety Equipment Co., 785 Lyons Ave., Irvington 11, N. J.
Partrick & Wilkins Co., 51 N. 7th St., Philadelphia 6, Pa.
Patterson Foundry & Machine Co., 41 Helene St., East Liverpool, Ohio.
Pattin Manufacturing Co., P. O. Box 527, Marietta, Ohio.
Patton Mfg. Co., 1802 W. Pleasant St., Springfield, Ohio.
Paulsen-Webber Cordage Corp., 170 John St., New York, N. Y.
Pease Co., C. F., 2601 W. Irving Park Rd., Chicago, Ill.
Peck & Harvey Mfg. Corp., 5650 North Western Ave., Chicago 45, Ill.
Peerless Electric Co., 1401 W. Market St., Warren, Ohio.
Peerless Photo Products, Inc., Shoreham, N. Y.
Penberthy Mfg. Co., 1242 Holden Ave., Detroit 2, Mich.
Pendleton Woolen Mills, Washougal, Wash.
Peninsular Grinding Wheel Div., 729 Meldrum Ave., Detroit 7, Mich.
Penn Machine Co., 106 Station St., Johnstown, Pa.
Penn Mfg. & Supply Co., 45 Westminster St., Wilkes-Barre, Pa.
Pennsalt Chemical Corp., 3 Penn Center, Philadelphia 2, Pa.
Pennsylvania Crusher Div. Bath Iron Works Corp., 323 S. Matlack St., West Chester, Pa.
Pennsylvania Drilling Co., 1201 Chartiers Ave., Pittsburgh 20, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Perkin Engineering Co., 345 Kansas St., El Segundo, Calif.
Perkins Machine & Gear Co., West Springfield, Mass.
Permagile Corp. of America, 37-23 33rd St., Long Island City 1, N. Y.
Permold Co., 800 W. Liberty St., Medina, Ohio.
Permutit Co., 330 W. 42nd St., New York 36, N. Y.
Peterson Filters & Engr. Co., 137 Social Hall Ave., Salt Lake City 1, Utah.
Pettibone Mulliken Corp., 4710 W. Division St., Chicago 51, Ill.
Pettinos, Inc., George F., 1206 Locust St., Philadelphia 7, Pa.
Phelps Dodge Copper Products Corp., 300 Park Ave., New York 22, N. Y.
Philadelphia Belting Co., 6th & Spring Garden Sts., Philadelphia 23, Pa.
Philadelphia Gear Works, G St., & Erie Ave., Philadelphia 34, Pa.
Philadelphia Quartz Co., 1135 Public Ledger Bldg., Philadelphia 6, Pa.
Philipp Bros, Inc., 70 Pine St., New York 5, N. Y.
Philips Electronics, Inc., Instruments Div., 750 S. Fulton Ave., Mt. Vernon, N. Y.
Phillips Petroleum Co., Bartlesville, Okla.
Phoenix Metal Products Co., 4715 N. 27th St., Milwaukee, Wis.
Pickard Industries, Inc., Central Mine Supply Co., Div., Mt. Vernon, Ill.
Pioneer Engineering Div. Poor & Co. Inc., 3200 Como Ave., Minneapolis 14, Minn.
Pitkin, Inc., Lucius, 47 Fulton St., New York 38, N. Y.
Pitman Mfg. Co., 300 W. 79 Terrace, Kansas City 14, Mo.
Pittsburgh Electrical & Machine Works, 1130 N. Franklin St., Pittsburgh 33, Pa.
Pittsburgh Gear Co., 27th and Smallman

Sts., Pittsburgh 22, Pa.
Pittsburgh Reflector Co., Oliver Bldg., Pittsburgh 22, Pa.
Pittsburgh Screw & Bolt Co., P. O. Box 1708 Pittsburgh 30, Pa.
Pittsburgh Steel Co., 1600 Grant Bldg., Pittsburgh 30, Pa.
Plastex Co., 3232 Cleveland Ave., Columbus 24, Ohio.
Plymouth Locomotive Works Div. Fate-Root-Heath Co., Plymouth, Ohio.
Plymouth Rubber Co., 51 Revere St., Canton, Mass.
Poole Foundry & Machine Co., 1700 Union Ave., Baltimore 11, Md.
Pollock Co., William B., 101 Andrews Ave., Youngstown, Ohio.
Porter-Cable Machine Co., 1714 N. Salina St., Syracuse 8, N. Y.
Porto Pump Inc., 19735 Ralston, Detroit 3, Mich.
Post Co., Frederick, 3650 N. Avondale Ave., Chicago 18, Ill.
Powell Co., Wm., 2525 Spring Grove Ave., Cincinnati 22, Ohio.
Powercraft Corp., 2215 De Kalb St., St. Louis 4, Mo.
Precision Grinding Wheel Co., Inc., 8301 Torresdale Ave., Philadelphia 36, Pa.
Precision Radiation Instruments, Inc., 4223 West Jefferson Blvd., Los Angeles 16, Calif.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.
Prime Mover Co., Muscatine, Iowa.
Princeton Griphoist, Inc., 32 George St., Boston 19, Mass.
Prins & Associates, K., Wellston, Ohio.
Process Engineering, Inc., Foot of Chase St., Methuen, Mass.
Productive Equipment Corp., 2926 W. Lake St., Chicago 12, Ill.
Prox Co., Frank, Inc., Terre Haute, Ind.
Proto Tool Co., 2209 Santa Fe Ave., Los Angeles 58, Calif.
Pulmosan Safety Equipment Corp., 644 Pacific St., Brooklyn, N. Y.
Pulva Corp., 602 High St., Perth Amboy, N. J.
Punch-Lok Co., 321 North Justine St., Chicago 7, Ill.
Pure Carbon Co., 441 Hall Ave., St. Marys, Pa.
Pure Oil Co., 35 E. Wacker Drive, Chicago 1, Ill.
Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.
Pyle-National Co., 1328 N. Kostner Ave., Chicago 51, Ill.

Quaker Rubber Div. H. K. Porter Company, Inc., Tacony & Comly Sts., Philadelphia 24, Pa.
Quay Industries, 2135 Riverside Avenue, Jacksonville 4, Fla.
Queen City Machine Tool Co., 3900 Kellogg Ave., Cincinnati 26, Ohio.
Quick Charge, Inc., 1750 N. E. 10th St., Oklahoma City, Okla.
Quick-Way Truck Shovel Co., P. O. Box 1800, Denver 1, Colo.
Quigley Co., Inc., 415 Madison Ave., New York 17, N. Y.

Radiation Counter Laboratories, 5121 W. Grove St., Skokie, Ill.
Radio Corp. of America, Communications Products Dept., Camden 2, N. J.
Rankin Manufacturing Co., 616 S. Marengo Ave., Alhambra, Calif.
Rattan Mfg. Co., 550 State St., New Haven 7, Conn.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge 42, Mass.
Raybestos-Manhattan, Inc. Manhattan Rubber Div., 42 Townsend St., Passaic, N. J.
Ray-O-Vac Co., 212 E. Washington Ave., Madison 10, Wis.
Reading Crane & Hoist Corp., Box 1139, Reading, Pa.
Ready Power Co., 11231 Freud Ave., Detroit, Mich.
Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.
Reed Roller Bit Co., Box 2119, Houston 1, Tex.
Reeves Pulley Co., Div. Reliance Electric & Engineering Co., 1225 Seventh St., Columbus, Ind.
Refractory & Insulation Corp., 120 Wall St., New York 5, N. Y.
REICH BROS. MFG. CO., 1439 Ash St., Terre Haute, Ind. Fourth cover.
Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis 4, Ind.
Reintjes Co., George P., 2519 Jefferson St., Kansas City 6, Mo.
Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.
REMINGTON ARMS CO., INC., 939 Barnum Ave., Bridgeport 2, Conn. Page 231.
Remington Rand Div. Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.
Reo Motors, Inc., 1331 S. Washington St., Lansing 20, Mich.
Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago 47, Ill.
Republic Rubber Div. Lee Rubber & Tire Corp., Albert St., Youngstown, Ohio.
Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio.
Republic Steel Corp. Truscon Steel Div., Albert St., Youngstown 1, Ohio.
Research-Cottrell, Inc., Bound Brook, N. J.
Resources Development Corp., 1540 Court Place, Denver, Colo.
Resisto-Loy Co., Inc., 1251 Phillips Ave., S. W., Grand Rapids 7, Mich.
Revere Copper & Brass, Inc., 230 Park Ave., New York 17, N. Y.
Revere Corp. of America, Wallingford, Conn.
Reynolds Metals Co., 2500 S. 3rd St., Louisville 1, Ky.
Rhoads & Son, J. E., 2100 W. Eleventh St., Wilmington 99, Del.
RIBLET TRAMWAY CO., 1231 N. Washington St., Spokane, Wash. Page 234.
Rice Pump & Machine Co., Belgium, Wis.
Richards-Wilcox Mfg. Co., 1176—3rd St., Aurora, Ill.
Richardson Scale Co., Clifton, N. J.
J. Murray Riddell, Box 144, Haughton, Mich.
Ridge Equipment Co., Fallentimber, Pa.
Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield, Ohio.
Roberts & Schaefer Co., Subsidiary of Thompson Starrett Co., Inc., Randolph-Wells Bldg., 130 North Wells St., Chicago 6, Ill.
Robinson Air-Activated Conveyor Systems, 80 Fifth Ave., New York 11, N. Y.
Robinson Clay Product Co., 65 West State St., Akron 9, Ohio.
Robinson Ventilating Co., Zelienople, Pa.
Rochester Ropes, Inc., Culpeper, Va.
Rockbestos Products Corp., Nicoll & Canner Sts., New Haven 4, Conn.
Rockford Bolt & Steel Co., 126 Mill St., Rockford, Ill.
Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.
Rockwell Spring & Axle Co., Timken-Detroit Axle Div., 100 Clark St., Detroit 32, Mich.
Rockwell Co., W. S., 200 Eliot St., Fairfield, Conn.
Roebling's Sons Corp., John A., Subsidiary of Colorado Fuel & Iron Co., 640 S. Broad St., Trenton 2, N. J.
Rogers Brothers Corp., Albion, Pa.
Rogers Iron Works Co., Joplin, Mo.
Rohm & Haas Co., 712 Locust St., Philadelphia, Pa.
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse 4, N. Y.
ROME CABLE CORP., 330 Ridge St., Rome, N. Y. Page 184.
Root & Simpson, Inc., 1306 E. 17th Ave., Denver 1, Colo.
Roots-Connersville Blower Div. Dresser Industries, Inc., 900 West Mount St., Connersville, Inc.
Rose Mfg. Co., 2700 W. Barberry Place, Denver 4, Colo.
Ross Heaat Exchanger Div. American Standard, Box 2081, Buffalo 5, N. Y.
ROSS SCREEN & FEEDER CO., 100 Quimby St., Westfield, N. J. Page 186.
Round & Son, Inc., David, P. O. Box 883, Cleveland 22, Ohio.
Ruberoid Co., 500 Fifth Ave., New York 36, N. Y.
Ruhr Industries, 1411 Walnut St., Philadelphia, Pa.
Rust-Oleum Corp. 2425 Oakton St., Evanston, Ill.
Ruth Co., 1437 Blake St., Denver 2, Colo.
Ryerson & Son, Inc., Joseph T., 16 & Rockwell Sts., P. O. Box 8000 A, Chicago 80, Ill.

SKF Industries, Inc., P. O. Box 6731, Philadelphia 32, Pa.
Safety Clothing & Equipment Co., 1990 E. 69th St., Cleveland 3, Ohio.
Safety First Shoe Co., Inc., Holliston, Mass.
Safety First Supply Co., 425 Magee St., Pittsburgh 19, Pa.
Saginaw Bearing Co., 821 South Water St., Saginaw, Mich.
St. Louis Malleable Casting Co., 7701 N. Conduit Ave., St. Louis 15, Mo.
St. Louis Screw & Bolt Co., 6900 North Broadway, St. Louis 15, Mo.
St. Regis Paper Co., 150 E. 42nd St., New York 17, N. Y.
Salem-Brosuis, Inc., P. O. Box 2222, Pittsburgh 30, Pa.
Salem Tool Co., Salem, Ohio.
Samuel & Co., Inc., Frank, 2200 Philadelphia National Bank Bldg., Philadelphia 7, Pa.
Sanderson Cyclone Drill Co., E. Chestnut St., Orrville, Ohio.
Sandvik Steel Inc., Steel Belt Conveyor Dept., Fair Lawn, N. J.
Sanford-Day Iron Works, Inc., Dale Ave., P. O. Box 1511, Knoxville 9, Tenn.
Sangamo Electric Co., Springfield, Ill.
Santa Fe Tank Div. Fluor Products Co., 12000 E. Washington Blvd., Whittier, Calif.
Sauereisen Cement Co., 1242 Sharpsburg St., Pittsburgh 15, Pa.
SAUERMAN BROS., INC., 626 S. 28th Ave., Bellwood, Ill. Page 222.
Savage Co., W. J., 912 Clinch Ave., S. W., Knoxville 2, Tenn.
Sawyer Belt Hook & Wedge Co., Inc., 16 Warren Ave., Pawtucket, R. I.
Scandinavia Belting Co., 744 Broad St., Box 464, Newark 1, N. J.
SCHAFFER POIDOMETER CO., 2828 Smallman St., Pittsburgh 22, Pa. Page 235.
Schatz Mfg. Co., Fairview Ave., Poughkeepsie, N. Y.
Schield Bantam Co., 221 Park St., Waverly, Iowa.
Schneible Co., Claude B., P. O. Box 81, North End Station, Detroit 2, Mich.
Schonrock Mfg. Co., San Angelo, Tex.
Schramm, Inc., 870 E. Virginia Ave., West Chester, Pa.
Schroeder Brothers, 3116 Penn Ave., Pittsburgh 1, Pa.
Scott Aviation Corp., Lancaster, N. Y.
Screen Equipment Co., Inc., 1750 Walden Ave., Buffalo 25, N. Y.
Seiberling Rubber Co., Akron 9, Ohio.
Seismograph Service Corp., P. O. Box 1590, Tulsa 1, Okla.
Sellstrom Mfg. Co., 217 So. Hicks Rd., Palatine, Ill.
Shaft & Development Machines, Inc., 808 Newhouse Bldg., Salt Lake City 11, Utah.
Sharples Corp., 2300 Westmoreland St., Philadelphia 40, Pa.
Sheffield Div. Armco Steel Corp., Sheffield Station, Kansas City 25, Mo.
Shell Oil Co., 50 W. 50th St., New York 20, N. Y.
Shepard Niles Crane & Hoist Corp., Schuyler Ave., Montour Falls, N. Y.
Sheppard Co., Inc., R. H., Hanover, Pa.
Sherwin-Williams Co., 101 Prospect Ave., N. W., Cleveland 1, Ohio.
Shrader Co., F. W., 11623 S. Broadway, Los Angeles 61, Calif.
Shriver & Co., T., 848 Hamilton St., Harrison, N. J.
Shwayder Chemical Metallurgy Corp., 684 E. Woodbridge, Detroit 26, Mich.
Sight Feed Generator Co., West Alexandria, Ohio.
Sika Chemical Corp., 33-47 Gregory Ave., Passaic, N. J.
Sikorsky Div. United Aircraft Co., East Hartford, Conn.
Silent Hoist & Crane Corp., 877—63rd St., Brooklyn 20, N. Y.
Simonds Saw and Steel Co., Fitchburg, Mass.
Simonds Worden White Co., Dayton 7, Ohio.
Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.
SIMPLICITY ENGINEERING CO., Durand, Mich. Page 208.
Simplicity System Co., Riverside Drive, Chattanooga, Tenn.
Sinclair Refining Co., 600 Fifth Ave., New York, N. Y.
Skinner Engine Co., 337 W. 12th St., Erie, Pa.
Skookum Co., Inc., 8504 N. Crawford St., Portland 3, Ore.
Slip-On, Inc., 401 Broadway, New York, N. Y.
Sly Mfg. Co., W. W., P. O. Box 5939, Cleveland 1, Ohio.
SMIDTH & CO., F. L., 11 West 42nd St., New York 36, N. Y. Page 177.
SMIT & CO., ANTON, 111 Eighth Ave., New York 11, N. Y. Page 246.
SMIT & SONS, INC., J. K., Murray Hill, N. J. Page 230.
Smith Co., A. O., 3533 North 27th St., Milwaukee 1, Wis.
Smith-Emery Co., 781 E. Washington Blvd., Los Angeles 21, Calif.
Smith Engineering Works, 502 East Capital Dr., Milwaukee 12, Wis.
Smith & Co., Gordon, 445 College St., Bowling Green, Ky.
Smith & Serrell, Inc., 200 Washington St., Newark 2, N. J.
Smith Welding Equipment Corp., 2633 S. E. 4th St., Minneapolis 14, Minn.
Snap-on-Tools Corp., 8026 28 Ave., Kenosha, Wis.
Snell, Inc., Foster D., 29 W. 15th St., New York 11, N. Y.
Snow-Nabstedt Gear Corp., 251 Welton St., Hamden 7, Conn.
Snyder & Son, Inc., M. L., 1811 E. York St., Philadelphia 25, Pa.
Socony Mobil Oil Co., 26 Broadway, New York 4, N. Y.
Solvay Process Div. Allied Chemical & Dye Corp., 61 Broadway, N. Y. 6, N. Y.
Sorel Steel Foundries, Ltd., Room 504, 1405 Peel St., Marine Bldg., Montreal 2, P. Q., Canada.
Sorgel Electric Co., 838-B W. National Ave., Milwaukee 4, Wis.
South Bend Lathe Works, 419 E. Madison St., South Bend 22, Ind.
Southern Carbon Brush Co., 7—18th St. S. W., Birmingham, Ala.
Southwestern Engineering Co., 4800 Santa Fe Ave., Los Angeles 58, Calif.
Southwestern Industrial Electronics Co., P. O. Box 13058, Houston 19, Tex.
Spang & Co., 143 Etna St., Butler, Pa.
Spartan Air Services, 74 Sparks St., Ottawa, Ont. Canada.
Special Instruments Laboratory, Inc., P. O. Box 2108, 312 W. Vine Ave., Knoxville, Tenn.
Specialty Engineering Co., 3300 Frankford Ave., Philadelphia 34, Pa.
SPECTROCHEMICAL LABORATORIES, INC., 1010 Wood St., Wilkinsburg, Pittsburgh 21, Pa. Page 241.
Speer Carbon Co., St. Marys, Pa.
Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo.
Spencer Turbine Co., 486 New Park Ave., Hartford 6, Conn.
Split Ballbearing Corp., 211 Mechanic, Lebanon, N. H.
SPRAGUE & HENWOOD, INC., 221 West Olive St., Scranton, Pa. Opp. Page 170.
SPRAYING SYSTEMS CO., Randolph St., Bellwood, Ill. Page 250.
Sprengnether Instrument Co., Inc., W. F., 4567 Swan Ave., St. Louis 10, Mo.
Springfield Boiler Co., 20th & E. Capitol Ave., Springfield, Ill.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Stackpole Carbon Co., St. Marys, Pa.
Stahl Gear & Machine Co., 3901 Hamilton Ave., Cleveland 14, Ohio.
STAMLER CORP., W. R., Box 79, Paris, Ky. Page 189.
Standard Elec. Mfg. Co., Inc., Haddon Ave., West Berlin, N. J.
Standard Metal Mfg. Co., Mallnta, Ohio.
STANDARD OIL CO. OF CALIFORNIA WESTERN OPERATIONS, INC., 225 Bush St., San Francisco 20, Calif. Page 145.
Standard Oil Co., — Indiana, 910 S. Michigan Ave., Chicago 5, Ill.
Standard Steel Corp., 5001 S. Boyle Ave., Los Angeles 58, Calif.
Standard Transformer Co., Warren, Ohio.
Stanley Electric Tools Div. Stanley Works, New Britain, Conn.
Stanley Co., Inc., William W., 401 Broadway, New York 13, N. Y.
Staplex Co. Air Sampler Div., 777 Fifth Ave., Brooklyn 32, N. Y.
Star Brass Works, 1501 Fulford St., Kalamazoo 24F, Mich.
Star Expansion, 142 Liberty St., New York 6, N. Y.
Star Jack Co., 420 Lexington Ave., New York 17, N. Y.
Star Wire Screen & Iron Works, Inc., 2515 San Fernando Road, Los Angeles 65, Calif.
Stardrill-Keystone Co., 920—17th St., Beaver Falls, Pa.
STEARNS MAGNETIC PRODUCTS, 635 S. 28th St., Milwaukee 46, Wis. Page 223.
STEARNS ROGER MFG. CO., 660 Bannock St. P. O. Box 5370, Denver 17, Colo. Page 140.
Steber Mfg. Co., 2700 Roosevelt Rd., Broadview, Ill.
Steel-Bilt Construction Co., Carol Ave., Bridgeville, Pa.
Steel City Electric Co., 1207 Columbus Ave., Pittsburgh 33, Pa.
Steelcraft Mfg. Co., 9017 Blue Ash Rd., Cincinnati 42, Ohio.
Steelduct Co., Republic Bldg., Youngstown 3, Ohio.
Stein, Hall & Co., Inc., 285 Madison Ave., New York, N. Y.
Stephens Adamson Mfg. Co., 4 Ridgeway Ave., Aurora, Ill.
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.
Sterling Grinding Wheel Co., Tiffin, Ohio.
Sterling Steel Casting Co., P. O. Box 230, East St. Louis, Ill.
Stewart-Warner Corp. Alemite Div., 1826 Diversey Parkway, Chicago 14, Ill.
Stimmel Winch Co., Inc., 37-24 33 St., Long Island City, N. Y.
Stockham Valves & Fittings, Birmingham, Ala.
Stone & Webster Engineering Co., 90 Broad St., New York, N. Y.
Stoody Co., P. O. Box 901, Whittier, Calif.
Stop-Fire, Inc., U. S. Highway 1 at Blackhorse Lane, New Brunswick, N.J.
Stowell & Co., W. H., W. 421 Sprague Ave., Spokane 4, Wash.
Stratoflex, Inc., P. O. Box 10398, Fort Worth, Tex.
Straub Mfg. Co., 8381 Baldwin St., Oakland 21, Calif.
Streeter-Amet Co., Grayslake, Ill.

Stroh Process Steel Co., 1428 High St., Pittsburgh 12, Pa.
Strong, Carlisle & Hammond Co., 1392 W. 3rd St., Cleveland 13, Ohio.
Strong Steel Foundry Co., Hertel & Norris Ave., Buffalo 7, N. Y.
Stulz-Sickles Co., 134 Lafayette St., Newark 5, N. J.
Sturrock & Co. Ltd., P. O. Box 2863, Johannesburg, South Africa.
STURTEVANT MILL CO., 103 Clayton St., Boston 22, Mass. Page 156.
Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa.
Superior-Lidgerwood-Mundy Corp., 1101 John Ave., Superior, Wis.
Sutphen, Peter O. Box 58, Everett, Pa.
Sutton Steele & Steele, Inc., 1031 South Haskell St., Dallas 23, Tex.
Suverkrop Instruments, P. O. Box 436, Bakersfield, Calif.
Swaby Mfg. Co., 3818 W. Armitage Ave., Chicago 47, Ill.
Swan-Finch Oil Corp., 338 Hudson St., Hackensack, N. J.
Sweet's Steel Co., 770 Sweet St., Williamsport, Pa.
Swepco Tube Corp., One Clifton Blvd., Clifton, N. J.
Swett Iron Works, A. L., 158 Glenwood Ave., Medina, N. Y.
Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.
Synthane Corp., River Rd., Oaks, Pa.
Syntron Co., 510 Lexington, Homer City, Pa.

Talcott, Inc., 81 Sabin St., Providence, R. I.
Talk-A-Phone Co., 1512 South Pulaski Rd., Chicago 23, Ill.
Taller & Cooper, Inc., 75 Front St., Brooklyn, N. Y.
Taylor Chain Co. Inc., S. G., 141 St. & Ind. Harbor Belt Tracks, Hammond, Ind.
Taylor Fibre Co., Norristown, Pa.
Taylor & Co., W. A., 7300 York Rd., Baltimore 4, Md.
Taylor-Wharton Co. Div. Harsco Corp., High Bridge, N. J.
Telluride Iron Works Co., 400 Main Ave., Durango, Colo.
Templeton, Kenly & Co., 16th & Gardner Rd., Broadview, Ill.
Tennessee Coal & Iron Div. U. S. Steel Corp., P. O. Box 599, Fairfield, Ala.
TENNANT SONS & CO., C. OF N. Y., 100 Park Ave., New York 17, N. Y. Page 240.
Terry Steam Turbine Co., 874 Windsor St., Hartford, Conn.
TEXAS CO., 135 E. 42nd St., New York 17, N. Y. Page 6.
Texas Gulf Sulphur Co., 75 East 45, New York, N. Y.
Texas Instruments, Inc. Industrial Instrumentation Div., 3609 Buffalo Speedway, Houston, Tex.
Thermoid Co. Industrial Div., Whitehead Rd., Trenton 6, N. J.
Thew Shovel Co., Lorain, Ohio.
Thiokol Chemical Corp., 780 North Clinton Ave., Trenton 7, N. Y.
Thomas & Betts Co., 36 Butler St., Elizabeth 1, N. J.
Thomas Flexible Coupling Co., Warren, Pa.
Thomas Foundries, Inc., P. O. Box 1111, Birmingham 1, Ala.
Thor Power Tool Co., Prudential Plaza, Chicago 1, Ill.
Throwaway Bit Corp., 4200 N. W. Yeon Ave., Portland 10, Ore.
Thurman Machine Co., 156 N. 5th St., Columbus, Ohio.
Timber Engineering Co., 1319—18th St., N. W. Washington 6, D. C.
Timken Roller Bearing Co., 1835 Dueber Ave., S. W., Canton 6, Ohio,
Titan Metal Mfg. Co., Bellefonte, Pa.
Titeflex, Inc., Hendee St., Springfield 4, Mass.
Toledo Pipe Threading Machine Co., 1445 Summit Ave., Toledo 4, Ohio.
Toledo Scale Co., 1002 Telegraph Rd., Toledo 1, Ohio.
Tool Steel Gear & Pinion Co., 211 Township Ave., Cincinnati 16, Ohio.
Torrington Co., 59 Field St., Torrington, Conn.
Torrington Co. Bantam Bearings Div., 3702 West Sample St., South Bend 21, Inc.
Torsion Balance Co., Clifton, N. J.
Tour & Co., Sam, 44 Trinity Pl., New York 6, N. Y.
Tracerlab, Inc., 1601 Trapelo Rd., Waltham 54, Mass.
Tractomotive Corp., County Line Rd., Deerfield, Ill.
Trans-Weigh Corp., Wayne, Pa.
Transport Trailers, Inc., 1230—12th St. S. W., Cedar Rapids, Iowa.
TRAYLOR ENGINEERING & MFG. CO., Allentown, Pa. Page 182.
Treadwell Co., M. H., 140 Cedar St., New York 6, N. Y.
Triangle Conduit & Cable Co., Inc., Triangle & Jersey Aves., New Brunswick, N. J.
Trico Fuse Mfg. Co., 2948 N. 5th St., Milwaukee 12, Wis.
Trojan Powder Co., 17 N. 7th St., Allentown, Pa.
Trombetta Solenoid Corp., 329 N. Milwaukee St., Milwaukee 2, Wis.
Troy Engine & Machine Co., 3 Railroad Ave., Troy, Pa.
Truck Engineering Corp., 1285 W. 70th St., Cleveland 2, Ohio.
Tube Turns Div. National Cylinder Gas Co., 224 East Broadway, Louisville 1, Ky.
Turbo-Mixer Div. General American Transportation Corp., 380 Madison Ave., New York 17, N. Y.
Turner Halsey Co., 40 Worth St., New York 13, N. Y.
Tweco Products, Inc., Boston at Mosley, Wichita 1, Kan.
TWIN DISC CLUTCH CO., Racine, Wis. Page 155.
Tyler Co., W. S., 3615 Superior Ave., Cleveland 14, Ohio.
Tyson Bearing Corp., Subsidiary of SKF Industries, Inc., Massillon, Ohio.

Uehling Instrument Co., 473 Getty Ave., Paterson 3, N. J.
Uhrden, Inc., Bennison, Ohio.
Ultra-Violet Products, Inc., 5114 Walnut Grove Ave., San Gabriel, Calif.
Union Asbestos & Rubber Co., 1111 West Perry St., Bloomington, Ill.
Union Carbide Chemicals Co. Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.
Union Chain & Mfg. Co., Sandusky, Ohio.
Union Wire Rope Corp., 2100 Manchester Ave., Kansas City 26, Mo.
Unit Crane & Shovel Corp., 6411 W. Burnham St., Milwaukee 19, Wis.
U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles 54, Calif.
U. S. Electrical Tool Co., 3640 Llewellyn St., Cincinnati 22, Ohio.
U. S. Gauge Div. American Machine & Metals, Inc., Sellersville, Pa.
U. S. Hoffman Machinery Corp. Air Appliance Div., 103 4th Ave., New York 3, N. Y.
U. S. Pipe & Foundry Co., 3300 First Ave., North, Birmingham 2, Ala.
U. S. Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
U. S. Rubber Co. Mechanical Goods Div., 1230 Ave. of the Americas, New York 20, N. Y.
U. S. Safety Service Co., 1331 Oak St., Dept. E, Kansas City 6, Mo.
U. S. Smelting Furnace Co., East A St. & L & N Tracks, Belleville, Ill.
U. S. Smelting, Refining & Mining Co. Inc., 57 Williams St., New York, N. Y.
U. S. STEEL CORP. COLUMBIA-GENEVA STEEL DIV., 120 Montgomery St., San Francisco 6, Calif. Pages 166, 170.
U. S. STEEL CORP. NATIONAL TUBE DIV., 525 Wm. Penn Place, Pittsburgh 30, Pa.
U. S. Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.
Universal Atomics Div. Universal Transistor Products Corp., 143 E. 49th St., New York 17, N. Y.
Universal Dredge Mfg. Co., 124 Wazee Market, Denver 4, Colo.
Universal Electric Sales Corp., 2557 E. 79th St., Cleveland 4, Ohio.
Universal Engineering Corp., 625 C Ave. N. W., Cedar Rapids, Iowa.
Universal Motor Co., 422 Universal Dr., Oshkosh, Wis.
Universal Road Machinery Co., Kingston, N. Y.
Universal Vibrating Screen Co., Deane Blvd & St. Paul RR, Racine, Wis.
Utah Construction Co., Shell Bldg., San Francisco, Calif.
Utility Mine Equipment Co., 1010 Collingwood Rd., St. Louis 24, Mo.

V. V. Fittings Co., 715 Cherry St., Philadelphia, Pa.
Vale Do Rio Doce Trading Co., Inc., 63 Wall St., New York 5, N. Y.
Valvoline Oil Co. Div. Ashland Oil & Refining Co., 639 Third Ave., Freedom, Pa.
Van Waters & Rogers, Inc., 4000—1st St., Seattle 4, Wash.
Vanadium-Alloys Steel Co., Latrobe, Pa.
Varel Mfg. Co., Box 13146, Dallas, Texas.
VASCOLOY-RAMET CORP., 800 Market St., Waukegan, Ill. Page 218.
Vickers Inc., Administrative & Engineering Center, Detroit 32, Mich.
VICTAULIC CO. OF AMERICA, Box 509, Elizabeth, N. J. Page 216.
Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.
VICTOR EQUIPMENT CO. ALLOY ROD & METAL DIV., 13808 East Imperial Highway, Norwalk, Calif. Page 178.
Visking Co., Plastics Div., P. O. Box 1410, Terre Haute, Ind.
Vitro Corp. of America, 261 Madison Ave., New York, N. Y.
Voland & Sons, Inc., P. O. Box 680, New Rochelle, N. Y.
Vulcan Electric Co., 88 Holten St., Danvers, Mass.
Vulcan Iron Works, 730 S. Main St., Wilkes-Barre, Pa.
VULCAN IRON WORKS CO., (DENVER), 1423 Stout St., Denver 2, Colo. Page 165.

Wadsworth Electric Mfg. Co., 20 W. 11th St., Covington, Ky.
Wagner Electric Corp., 6401 Plymouth Ave., St. Louis, Mo.
WAH CHANG CORP., 233 Broadway, New York 7, N. Y. Page 214.
Waldron Corp., John, River Rd., New Brunswick, N. J.
Walker Brothers, Spring Mill Rd., Conshohocken, Pa.
Walker & Whyte, Inc., 409 Pearl St., New York 7, N. Y.
Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.
Walter Motor Truck Co., 1001 Irving Ave., Ridgewood 27, Queens, Long Island, N. Y.
Waltham Grinding Wheel Co., Waltham 54, Mass.
Walvoord, Inc., O. W. 300 Detroit St., Denver 6, Colo.
Walworth Co., 60 E. 42nd St., New York 17, N. Y.
Warn Mfg. Co., Box 6064 Riverton Branch, Seattle 88, Wash.
Warren-Knight Co., 136 N. 12th St., Philadelphia 7, Pa.
Warren Steam Pump Co., Warren, Mass.
Washington Iron Works, 1520—6th Ave. S., Seattle 4, Wash.
Washington Machinery Co., 7329 E. Marginal Way, Seattle β, Wash.
Watt Car & Wheel Co., Barnesville, Ohio.
Waukesha Motor Co., Waukesha, Wis.
Weatherhead Co. Fort Wayne Div., 128 W. Washington St., Fort Wayne, Ind.
Webb Corp., Box 549, Webb City, Mo.
Webb Belting & Supply Co., 1501-07 W. 12th St., Kansas City 1, Mo.
Webb Co., Jervis B., 8957 Alpine Ave., Detroit 4, Mich.
Webster Mfg., Inc., Tiffin, Ohio.
WEDGE WIRE CORP., Gas St. & N. P. R. R., Wellington, Ohio. Page 196.
Weinman Pump Mfg. Co., 270 Spruce St., Columbus 8, Ohio.
Wellington Sears Co., 65 Worth St., New York, N. Y.
Wellman Engineering Co., McDowell Enterprise, 7000 Central Ave., Cleveland 4, Ohio.
Wellman Co., S. K., 200 Egbert Rd., Bedford, Ohio.
West End Chemical Co., 608 Latham Square Bldg., Oakland, Calif.
Western Block Co., 247 Market St., Lockport, N. Y.
Western Gear Corp., 2600 E. Imperial Highway, Lynwood, Calif.
Weestern Insulated Wire Co., 2425 E. 30th St., Los Angeles, Calif.
WESTERN MACHINERY CO., 650 Fifth St., San Francisco 7, Calif. Opp. Page 186.
Western Precipitation Corp., 1016 W. 9th St., Los Angeles 15, Calif.
Western Radiation Laboratory, 1107 W. 24th St., Los Angeles 7, Calif.
WESTERN ROCK BIT MFG. CO., 552 W. 7th South St., Salt Lake City 4, Utah. Page 150.
Westfalia Lunen c/o Mining Progress Inc., Highland Mills, N. Y.
WESTINGHOUSE AIR BRAKE CO., 3 Gateway Center, Pittsburgh 22, Pa.
WESTINGHOUSE AIR BRAKE CO., IND. PRODUCTS DIV., Wilmerding, Pa.
Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa.
Westinghouse Electric Corp. Sturtevant Div., Hyde Park, Boston 36, Mass.
Weston Electrical Instrument Corp. Subsidiary of Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.
West Virginia Armature Co., Pine St., Bluefield, W. Va.
West Virginia Belt & Cable Repairs, Inc., P. O. Box 361, Mt. Hope, W. Va.
West Virginia Pulp & Paper Co., 230 Park Ave., New York 17, N. Y.
West Virginia Works Connors Steel Div. H. K. Porter Company., Inc. (Delaware), P. O. Box 118, Huntington 6, W. Va.
Wheel Trueing Tool Co., 3200 W. Davison Ave., Detroit 38, Mich.
Wheelabrator Corp., 1202 S. Byrkit St., Mishawaka, Ind.
Wheelco Instr. Div. Barber-Colman Co., 1300 Rock St., Rockford, Ill.
Wheeler Insulated Wire Co., Div. Sperry Rand Corp., Waterbury, Conn.
Wheeler Mfg. Co., C. H., Lehigh & Sedgley Aves., Philadelphia 32, Pa.
Wheeling Steel Corp., 1134-1140 Market St., Wheeling, W. Va.
White Diesel Engine Div. White Motor Co., 1401 Sheridan Ave., Springfield, Ohio.
White, Instrument Co., David., 2051 N. 19th St., Milwaukee 5, Wis.
White Lamb Finaly, Inc., 204 Chancellor St., Philadelphia 6, Pa.
Whites Electronics, 1218 M Street, Sweet Home, Ore.
Whiting Corp., 157th St., Harvey, Ill.
Whitmore Mfg. Co., P. O. Box 1640, Station C., Cleveland 4, Ohio.
Whitney Chain Co., 237 Hamilton St., Hartford 2, Conn.
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp., 575 Madison Ave., New York 22, N. Y.
Wilbur & Williams Co., 130 Lincoln St., Brighton, Boston 35, Mass.
Wilcox Mfg. Co., P. O. Box 217, Raleigh, W. Va.
Wild Heerbrugg Instruments, Inc., Main & Covert Sts., Port Washington, N. Y.
Wiley Mfg. Co., Port Deposit, Md.
WILFLEY & SONS, A. R., Denham Bldg. P. O. Box 2330, Denver 2, Colo. Page 256.
Wilkerson Corp., 1601 West Girard Ave., Englewood, Colo.
Willey's Carbide Tool Co., 1340 West Vernon Highway, Detroit, Mich.
Williams & Son, E. A., 325 Washington Ave., Carlstadt, N. J.
Williams, I. B. & Sons, 51 Washington St., Dover, N. H.
Williams Patent Crusher & Pulverizer Co., 810 Montgomery St., St. Louis 6, Mo.
Willson Products Div. Ray-O-Vac Co., 200 Thorn St., Reading, Pa.
Willys Motors, Inc., Administration Bldg., Toledo, Ohio.
Wilson Rubber Co., 1200 Garfield Ave., S. W., Canton 6, Ohio.
Wincharger Corp., Zenith Radio Corp., Sioux City, Iowa.
Windeler Co., Ltd., George, 2201 Jerrold Ave., San Francisco 24, Calif.
Wing Mfg. Co., L. J., 303 Vreeland Mills Rd., Linden, N. J.
Winslow Engineering & Mfg. Co., 4069-73 Hollis St., Oakland 8, Calif.
Winston Bros. Co., 301 Clifton Ave., Minneapolis 3, Minn.
WINTER WEISS CO., 2201 Blake St., Denver 5, Colo. Page 228.
Wintroath Pumps Div. Worthington Corp. 1100 S. Meridian Ave., Alhambra, Calif.
Wire Rope Corp. of America, Inc., 609 N. 2nd St., St. Joseph, Mo.
Wisconsin Motor Corp., Milwaukee 46, Wis.
Witte Engine Works Oil Well Supply Div. U. S. Steel Corp., 1600 Oakland Ave., Kansas City 26, Mo.
Wodack Electric Tool Corp., 4627 W. Huron St., Chicago 44, Ill.
Wolf Safety Lamp Co. of America, Inc., 227 Grand Ave., Brooklyn 5, N. Y.
Wood Assaying Co., Henry E., 733 West Colfax, Denver 4, Colo.
Wood Shovel & Tool Co., Roosevelt & Clark Ave., Piqua, Ohio.
Wood Steel Co., Alan Wood Rd., Conshohocken, Pa.
Wood's Sons Co., T. B. Chambersburg, Pa.
Wooldridge Mfg. Div. Continental Copper & Steel Industries Inc., P. O. Box 127, Sunnyvale, Calif.
Worthington Corp., Worthington Ave., Harrison, N. J.
Wright Power Saw & Tool Corp., Subsidiary of Thomas Industries, 1419 Illinois Ave., Sheboygan, Wis.
Wyandotte Chemicals Corp., Michigan Alkali Div., Wyandotte, Mich.

Yale & Towne Mfg. Co. Yale Materials Handling Div., 11,000 Roosevelt Blvd., Philadelphia 15, Pa.
Yara Engineering Corp. Interstate Equipment Div., 18 West Jersey St., Elizabeth 4, N. J.
Yardney Electric Corp., 40-46 Leonard St., New York 13, N. Y.
Yarnall-Waring Co., 102 E. Mermaid Lane, Chestnut Hill, Philadelphia 18, Pa.
Yaun Mfg. Co., Inc., 2120 North Third St., P. O. Box 1508, Baton Rouge, La.
Youngstown Sheet & Tube Co., Stambaugh Bldg., Youngstown 1, Ohio.
Yuba Manufacturing Co., 351 California St., San Francisco 4, Calif.

Zophar Mills, Inc., 118-26th St., Brooklyn 32, N. Y.
Zurn Mfg., J. A., Div. Zurn Industries, Inc., 1955 Pittsburgh Ave., Erie, Pa.

3. Sales Offices

A

ADAMAS CARBIDE CORP.
Market St., Kenilworth, N. J.

AERO SERVICE CORP.
210 E. Courtland St., Philadelphia 20, Pa.

California, San Francisco: 68 Post St., Room 420

Minnesota, Duluth: 500 Christie Bldg., 120 North Fourth Ave.

Oklahoma, Tulsa: 1401 S. Detroit St.

Utah, Salt Lake City: 33 Richards St.

WM. AINSWORTH & SONS, INC.
2151 Lawrence St., Denver 2, Colo.

ALDON CO.
3338 Ravenswood Ave., Chicago, Ill.

ALLEN-SHERMAN-HOFF PUMP CO.
259 East Lancaster Ave., Wynnewood, Pa.

Illinois, Chicago 5: 407 Dearborn St.

New York, New York 16: 271 Madison Ave.

ALLIS-CHALMERS MFG. CO
1126 S. 70th St., Milwaukee 1, Wis.

Arizona, Phoenix: 3300 N. Central Ave.

California, Los Angeles 13: 417 S. Hill

California, San Francisco 7: 650 Harrison St.

Colorado, Denver 4: 655 Broadway Bldg.

Illinois, Chicago 3: 135 S. LaSalle St.

Massachusetts, Boston 16: 31 St. James

Minnesota, Duluth 2: 10 E. Superior St.

Minnesota, Minneapolis 2: 821 Marquette Ave.

Montana, Butte: 81 Hirbour Bldg.

New Mexico, Albuquerque: 323 Third St. S. W.

New York, N. Y. 7: 50 Church St.

Ohio, Cleveland 14: 815 Superior Ave., N. E.

Pennsylvania, Philadelphia 3: 1617 Pa. Blvd.

Texas, Dallas 2: 1800 N. Market St.

Utah, Salt Lake City 1: 136 S. Main St.

Washington, Spokane 1: West 422 Riverside Ave.

AMERICAN MANGANESE STEEL DIV., AMERICAN BRAKE SHOE CO.
389 East 14th St., Chicago Heights, Ill.

Arizona, Phoenix: 308 E. Lamar Rd.

California, Los Angeles 58: 5805 Downey Rd.

California, Oakland 7: 850 Ferry St.

Colorado, Denver 4: 4th & Wazee Sts.

Delaware, New Castle.

Illinois, Chicago 6: 155 N Wacker Dr.

Illinois, Chicago Heights: 389 E. 14th St.

Minnesota, Duluth: 100 Elizabeth St.

Missouri, St. Louis 14: 6600 Ridge Ave.

New York, New York 17: 230 Park

North Carolina, Asheville: Edgewood Knoll Apts. No. 16D.

Pennsylvania, Pittsburgh 19: 717 Grant Bldg.

Utah, Salt Lake City: 1837 N. Woodside Dr.

Canada, Quebec: Joliette, Montreal: 1405 Peel St.

AMERICAN BRATTICE CLOTH CORP.
Warsaw, Ind.

AMERICAN CYANAMID CO.
Mining Chemicals Dept., 30 Rockefeller Plaza, New York 20, N. Y.

California, Oakland: 1440 Broadway

Texas, El Paso: c/o Bailey Warehouse Co. 450 Canal St.

Washington, Sokane: c/o Goodwin-Mayflower Warehouse 155 S. Stevens St.

AMERICAN METAL CO.
61 Broadway, New York, N. Y.

AMERICAN MINE DOOR CO.
2039 Dueber Ave., S. W., Canton 6, Ohio.

AMERICAN SMELTING & REFINING CO.
120 Broadway, New York 14, N. Y.

ANACONDA WIRE AND CABLE CO.
25 Broadway, New York 4, N. Y.

California, Los Angeles 17: 807 Architects Bldg.

California, San Francisco 4: Room 2375, 120 Montgomery St.

Colorado, Denver 2: Room 706, Railway Exchange Bldg., 909 Seventeenth St.

Illinois, Chicago 6: 20 North Wacker Dr.

Louisiana, New Orleans 12: 601 Hibernia Bank Bldg.

Massachusetts, Cambridge 42: Kendall Square Bldg., 238 Main St.

Michigan, Detroit 2: 621 New Center Bldg.

Minnesota, Minneapolis 2: Room 2615, Foshay Tower, 821 Marquette Ave.

Missouri, St. Louis 8: 400-401 Continental Bldg., 3615 Olive St.

New York, New York 6: Room 2611-12, 21 West St.

North Carolina, Charlotte 2: 213 Wilder Bldg.

Pennsylvania, Philadelphia 3: Room 1016, 1616 Walnut St. Bldg.

Pennsylvania, Pittsburgh 22: 1526 Bldg. No. 3, Gateway Center

Texas, Dallas 1: 1201 Fidelity Union Life Bldg., 1511 Bryan St.

Washington, Seattle 1: 954 Stuart Bldg., Metropolitan Center

West Virginia, Charleston 1: 501, 503, 505 Peoples' Bldg.

Wisconsin, Milwaukee 3: Room 368 Bockl Bldg., 2040 West Wisconsin

AROS ELECTRIC, INC.
500 Fifth Ave., New York 36, N. Y.

ASSOCIATED METALS & MINERALS CORP.
75 West St., New York 6, N. Y.

California, San Francisco: 593 Market

ATHEY PRODUCTS CORP.
5631 West 65th St., Chicago 38, Ill.

ATLAS POWDER CO.
Wilmington 99, Del.

California, Los Angeles 13: 805 Equitable Life Bldg., 411 W. 5th St.

California, San Francisco 4: 807 Crocker First Nat'l Bank Bldg., 1 Montgomery St.

Colorado, Denver 9: 2390 S. Delaware

Massachusetts, Boston: 1110 Statler Office Bldg.

Michigan, Houghton: Box 72

New York, New York 17: 60 E. 42nd St.

Oklahoma, Picher: Box 158, West A. St.

Oregon, Portland 4: 1001 Pacific Bldg., 520 S. W. Yamhill St.

Pennsylvania, Pittsburgh 22: Oliver Bldg., Mellon Sq.

Pennsylvania, Tamaqua: 601 Schuylkill Ave., Box #71.

Pennsylvania, Wilkes-Barre: Miners National Bank Bldg.

Utah, Salt Lake City 1: 823 Continental Bank Bldg., 200 S. Main St.

Washington, Seattle: 1320 Joseph Vance Bldg.

Washington, Spokane 36: East 1215 39th

AUSTIN - WESTERN, CONSTRUCTION EQUIPMENT DIV., BALDWIN-LIMA-HAMILTON CORP.
Aurora, Ill.

B

BABCOCK & WILCOX CO.
161 East 42nd St., New York 6, N. Y.

BALDWIN-LIMA-HAMILTON CORP.
Construction Equipment Div., South Main St., Lima, Ohio

BARBER-GREENE CO.
400 North Highland Ave., Aurora, Ill.

BIN-DICATOR CO.
13946 Kercheval St., Detroit 15, Mich.

BIRD MACHINE CO.
South Walpole, Mass.

BIXBY-ZIMMER ENGINEERING CO.
961 Abingdon St., Galesburg, Ill.

BLAW-KNOX CO.
Blaw-Knox Bldg., 300 Sixth Ave., Pittsburgh 22, Pa.

BOLTON FARM PACKING CO., INC.
176 Oak St., Newton 64, Mass.

BOOTH CO.
333 West 14 South St., Salt Lake City 4, Utah

BOYLES BROS. DRILLING CO. (UTAH)
1321 South Main St., Salt Lake City, Utah

BROOKVILLE LOCOMOTIVE WORKS
Steele Blvd., Brookville, Pa.

BRUNNER & LAY, INC.
9300 King St., Franklin Park, Ill.

California, Los Angeles: 2425 E. 37th

Colorado, Denver: 2 Santa Fe Dr.

North Carolina, Asheville: Sweeten Creek Rd.

Oregon, Portland: 660 N. Tillamook St.

Pennsylvania, Philadelphia: 2514 East Cumberland St.

Texas, Dallas: 150 Leslie St.

BUELL ENGINEERING CO.
70 Pine St., New York 5, N. Y.

BUILDERS - PROVIDENCE DIV., B-I-F INDUSTRIES
345 Harris Ave., Providence, R. I.

C

CALABRIAN CO., INC.
141 Broadway, New York, N. Y.

CARD IRON WORKS, C. S.
2501 West 16th Ave., Denver 4, Colo.

CARPCO MANUFACTURING INC.
4120 Haines Street, Jacksonville 6, Fla.

Australia, Brisbane, Queensland: 22-24 Thurlow St., Newmarket, NW.1

CHEATHAM ELECTRIC SWITCHING DEVICE CO.
4780 Crittenden Drive, Louisville 9, Ky.

CHICAGO PNEUMATIC TOOL CO.
6 East 44th St., New York 17, N. Y.

CHRISTENSEN DIAMOND PRODUCTS CO.
1937 South 2nd West, Salt Lake City, Utah

Ohio, Cincinnati 38: 3363 Queen City Ave.

COLORADO IRON WORKS CO.
(Subsidiary of Mine & Smelter Supply Co.) 3800 Race St., P. O. Box 9041, Denver 16, Colo.
COPPUS ENGINEERING CORP.
Worcester 2, Mass.
CRUCIBLE STEEL CO. OF AMERICA
Henry W. Oliver Building, Mellon Square, Pittsburgh 22, Pa.
California, Los Angeles 22: 6033 East Bandini Blvd.
California, San Francisco 10: 2050 Bryant St.
Colorado, Denver 17: 63rd Avenue & Colorado Blvd., P. O. Box 5084
Illinois, Chicago 39: 4501-4531 W. Cortland St.
Massachusetts, Boston: 129-135 Binney St., Cambridge 42, Mass.
Michigan, Detroit 34: 4920 E. Nevada
Minnesota, St. Paul 4: 1353 Laurel Ave.
New Jersey, Harrison: P. O. Box 28, 1000 South Fourth St.
Pennsylvania, Philadelphia: P. O. Box 7557, 408 S. Oak Lane Ave., Primos.
Pennsylvania, Pittsburgh 30: P. O. Box 88
Washington, Seattle 4: 2755 First Ave. South
Wisconsin, Milwaukee 9: 4200 West Douglas Rd.
Canada, Toronto 5, Ontario: 410 Bloor St., East

D

DART TRUCK CO.
2623 Oak Street, Kansas City, Mo.
Iowa, Des Moines: 6503 S. W. 17th St.
New York, Long Beach: 23 Virginia
Ohio, Cleveland: Westlake Hotel
Texas, Dallas: 3513 Hanover St.
Utah, Bountiful: 944 East Center St.
DENVER EQUIPMENT CO.
Box 5268, 1400 17th St., Denver 17, Colo.
Illinois, Chicago 1: Old Republic Bldg.
New York, New York: Empire State Bldg.
DIAMOND DRILL CONTRACTING CO.
Station B—Box 4065, South 18 Stone St., Spokane 15, Wash.
DIAMOND TOOL RESEARCH CO. INC.
380 Second Ave., New York 10, N. Y.
California, Los Angeles: 220 West 5th St., Western Div.
DIESEL ENERGY CORP.
82 Beaver St., New York, N. Y.
DINGS MAGNETIC SEPARATOR CO.
4740 W. Electric Ave., Milwaukee 46, Wis.
California, Los Angeles 22: 2112 South Atlantic Blvd.
California, San Francisco: 420 Market
Colorado, Denver 4: 660 Bannock St.
Illinois, Chicago 44: 4754 Washington Blvd.
Massachusetts, Needham Heights: 50 Kearney Rd.
Michigan, Detroit 8: 2055 West Grand Blvd.
Michigan, Ishpeming: 115 South First
Minnesota, Hibbing: 2905 First Ave.
Minnesota, St. Paul: 2580 University
Missouri, St. Louis 5: 7530 Forsyth Blvd.
Oregon, Portland 15: P. O. Box 5232.
Pennsylvania, Pittsburgh 22: 803 Investment Bldg., 4th Ave.
Texas, Dallas: 5542 Dyer St.
Utah, Salt Lake City 10: P. O. Box 209, 545-585 West Eighth South St.
Washington, Seattle 4: 1016 First Ave., South
Wisconsin, Milwaukee: 808 N. Third St.
Canada, British Columbia, Vancouver: 1661 West Fifth Ave.
Canada, Ontario, Toronto 1: 85 Richmond St., West
Canada, Quebec, Montreal 2: P. O. Box 99, N. D. G. Station, 5875 Upper Lachine Rd.
DRAVO CORP.
Neville Island, Pittsburgh 25, Pa.
Dravo Bldg., Fifth & Liberty Aves., Pittsburgh 22, Pa.
California, San Francisco 5: 702 Monadnock Bldg.
Illinois, Chicago 4: 208 South LaSalle
Massachusetts, Boston 9: 79 Milk St.
Michigan, Detroit 2: 409 S. Boulevard Bldg.
Missouri, St. Louis 17: 1110 S. BrentwoodBlvd.
New York, New York 6: 19 Rector St.
Ohio, Cleveland 3: 4207 Chester Ave.
Pennsylvania, Philadelphia 3: 1483 Suburban Station Bldg.

E

EIMCO CORP.
634 South 4th West, Salt Lake City, 10, Utah
Alabama, Birmingham: 3140 Fayette
Calif., Berkeley: 637 Cedar St.
Calif., San Mateo: 420 Peninsular Ave
Colo., Grand Junction: P. O. Box 153
Idaho, Kellogg: 307 N. Division St.
Illinois, Palatine: 301 So. Hicks Rd.
Minnesota, Duluth 5: 1823 E. Superior
New York, New York 5: 51-52 South St.
Pa., Pittsburgh 28: 666 Washington Rd.
Texas, El Paso: Mills Bldg.
Washington, Seattle: 208 Hoge Bldg.
ELECTRIC STORAGE BATTERY CO. EXIDE INDUSTRIAL DIV.
42 S. 15th St., Philadelphia 2, Pa.
ELEKTROKEMISK A. S.
101 Park Ave., New York, N. Y.
ENSIGN-BICKFORD CO.
24 S. Hopmeadow St., Simsbury, Conn.
EQUIPMENT ENGINEERS, INC.
41 Sutter St., San Francisco 4, Calif.

F

FALK CORP.
3049 W. Canal St., Milwaukee 1, Wis.
California, Los Angeles 22: 1068 S. Vail Ave.
California, San Francisco 5: 53 Stevenson St.
Colorado, Denver 3: 655 Broadway Bldg.
Illinois, Chicago 3: 105 W. Adams St.
Massachusetts, Boston: 432 Massachusetts Ave., Arlington 74
Michigan, Detroit 20: 22932 Woodward
Minnesota, Minneapolis 4: 807 Thirteenth Ave. South
Missouri, St. Louis 5: 8029 Forsyth Blvd.
New York, New York 7: 50 Church St.
Ohio, Cleveland 15: 2036 E. 22nd St.
Oregon, Portland 14: 1035 S. E. 9th
Pennsylvania, Philadelphia: 205 Long Lane, Upper Darby
Pennsylvania, Pittsburgh 19: 410 Grant Bldg.
Washington, Seattle 9: 1500 Westlake North
Wisconsin, Milwaukee 1: 3001 W. Canal
FEDERATED METALS DIVISION, AMERICAN SMELTING & REFINING CO.
120 Broadway, New York 5, N. Y.
California, Los Angeles 23: 4010 East 26th St.
California, San Francisco 24: 1901 Army
Michigan, Detroit 11: 11630 Russell St.
Ohio, Cleveland: 1152 Hanna Bldg.
Oregon, Portland 9: 1900 N. W. 19th
Pennsylvania, Pittsburgh 24: 615 Gross
Minnesota, Minneapolis: 1600 W. Lake
Texas, El Paso: 1213 Mills Bldg.
Utah, Salt Lake City 1: 700 Crandall Bldg.
Washington, Seattle 4: 101 Dakota St.
Wisconsin, Milwaukee 10: 4608 W. Burleigh St.
FEDERAL SIGN AND SIGNAL CORP.
8700 South State St., Chicago 19, Ill.
FLEXAUST CO.
100 Park Ave., New York 17, N. Y.
FLY ASH ARRESTOR CORP.
275 1st St. North, Birmingham, Ala.
Illinois, Chicago: Dravo Corp., Machinery Div., 208 South LaSalle St.
Massachusetts, Boston: W. H. Brackett Co., 131 Clarendon St.
Minnesota, Minneapolis: R. K. Culbertson Co., 6524 Walker St.
New York, New York: 420 Lexington
Pennsylvania, Pittsburgh: Dravo Corp., Machinery Div., Dravo Bldg.

G

GALIGHER CO.
P. O. Box 209, Salt Lake City 10, Utah
GARDNER DENVER CO.
Quincy, Ill.
California, Los Angeles 22: 7654 E. Slauson Ave.
California, San Francisco 7: 811 Folsom St.
Colorado, Denver 1: 1727 E. 39th Ave., P. O. Box 1020
Idaho, Wallace: 407 Seventh St., P. O. Box 788
Louisiana, New Orleans 25: 7735 Edinburgh St., P. O. Box 13155
Minnesota, Duluth 2: 521 East Superior
Montana, Butte: 215 E. Park St.
New York, New York 7: 233 Broadway, Woolworth Bldg.
Ohio, Cleveland 11: 3088 W. 117th St.
Pennsylvania, Hazelton: P10. Box 17
Pennsylvania, Philadelphia 40: 4309-11 Rising Sun Ave.
Texas, Dallas 35: 7125 Harry Hines Blvd., P. O. Box 35106
Utah, Salt Lake City: 113 W. Second South St.
Washington, Seattle 4: 615 Eighth Ave. South
Australia, Artarmon, N. S. W.: 70 Hotham Parade
Canada, Edmonton, Alberta: 14415-114
Canada, Moncton, New Brunswick: E. Main St., P. O. Box 475
Canada, Montreal 28, Quebec: 5411 Western Ave.
Canada, Nelson, B. C.: 337 Baker St.
Canada, Toronto 16, Ontario: 14 Curity Ave.

Canada, Vancouver 9, B. C.: 1775 Pine
Canada, Winnipeg 3, Manitoba: 1400 Sargent Ave.
Northern Rhodesia, Ndola: P. O. Box 18, Alacrity House, Cr. Third St. & Monterey Ave.
Mexico, Mexico City 6, D. F.: Apartado 575
South America, Lima, Peru: Apartado 674
South America, Rio de Janeiro, Brazil: Avenida Churchill 94-B, Caixa Postal 4293
Union of S. Africa: Johannesburg Transvaal: P. O. Box 4807

GATES RUBBER CO.
999 South Broadway, Denver 17, Colo.
California, Los Angeles 58: 2850 E. 46th St.
California, South San Francisco: 242 Shaw Rd.
Illinois, Chicago 32: 3035 West 47th St.
Michigan, Detroit 27: 15844 Schaefer Highway
New York, New York City 3: 215-219 Fourth Ave.
North Carolina, Charlotte 3: 1401 S. Mint St.
Oregon, Portland 10: 2551 N. W. 30th
Pennsylvania, Philadelphia 6: 1306 Mall Bldg.
Texas, Dallas 2: 1130 Dragon St.
Wisconsin, Milwaukee 8: 831 N. 27th

GENERAL CABLE CORP.
420 Lexington Ave., New York 17, N. Y.

GENERAL CHEMICAL DIV., ALLIED CHEMICAL & DYE CORP. (BAKER & ADAMSON PRODUCTS)
40 Rector St., New York 6, N. Y.

GENERAL REFRACTORIES CO.
1520 Locust St., Philadelphia, Pa.

GODOY & CO., INC., E. A.
25 Broadway, New York 4, N. Y.

GORDON I. GOULD & CO.
58 Sutter St., San Francisco 4, Calif.

GRINNELL CO., INC.
260 West Exchange St., Providence 1, R. I.
Calif., Fresno 1: 3081 Hamilton Ave.
Calif. Los Angeles 13: 520 Mateo St.
Calif., Long Beach 10: 1360 W. Pacific Coast Highway
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Calif., San Francisco 7: 601 Brannan St.
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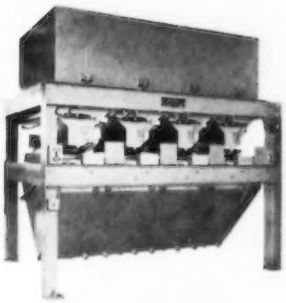
San Francisco 4 ...J. W. Otterson, 68 Post St. Douglas 2-4600

London EC 4, England ...H. Lagler, McGraw-Hill Co., Ltd., 95 Farringdon St.

ON THE go

by J. Hall Carpenter



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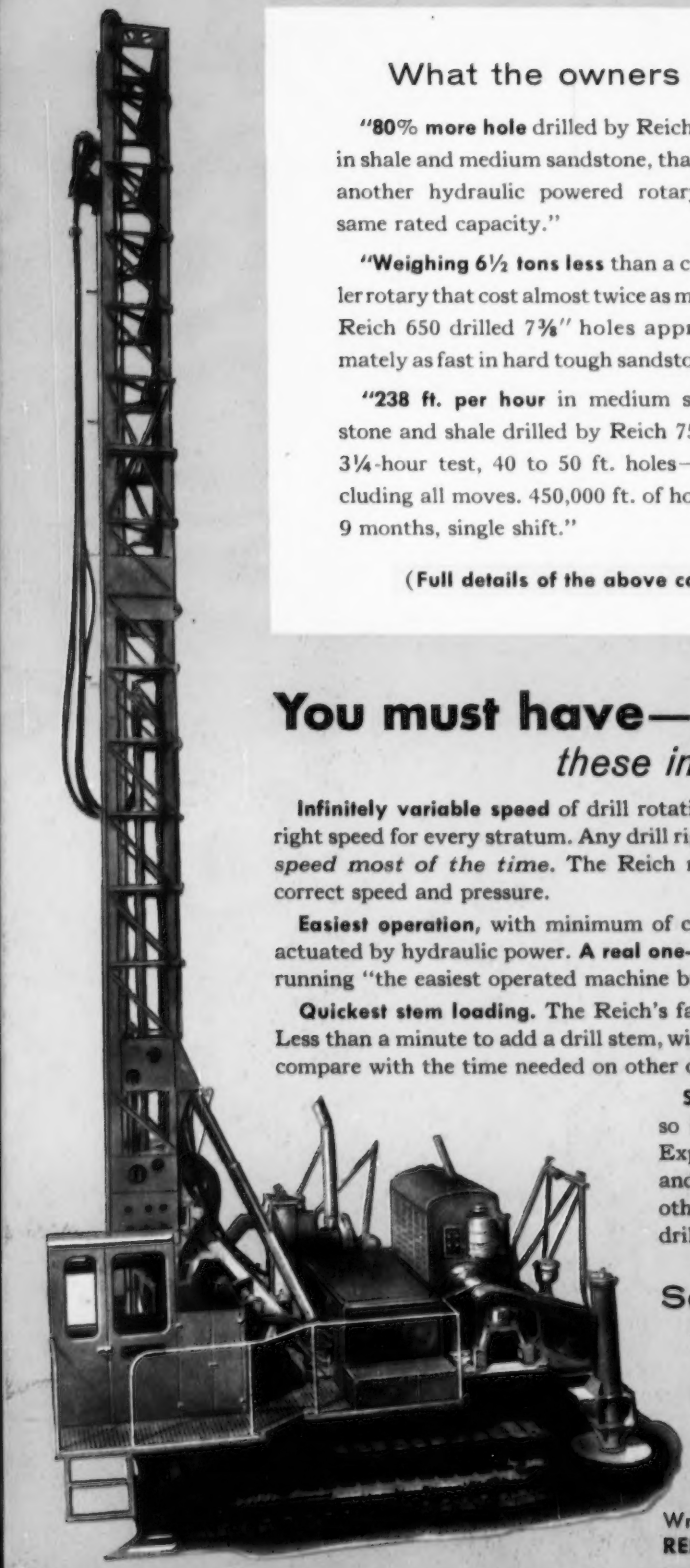

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